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The Association of Foot Hygiene Level with Tinea Pedis Incidence in Military Personnel

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Abstract

Tinea pedis is a condition of fungal infection of the skin on the bottom of the feet which causes disruption to the integrity of the skin in that area. Tinea pedis usually appears in damp environmental conditions, long-term wearing of closed shoes, and poor hygiene. TNI has a potentially high risk of Tinea pedis infection. This study aims to provide an overview members of the Indonesian National Army (TNI) who have a high potential risk of Tinea pedis infection. The study adopts a descriptive analysis employing a cross-sectional design. The research is focused on the military personnel of the Raider Infantry Battalion 328 Kostrad Cilodong. The sample size for this study was determined to be 70 individuals using the Slovin formula. Data collection involved the use of questionnaires and foot skin scrapings. The analysis was conducted using the Chi-square test. The data collection process took place in December 2023. The results showed most soldiers of Infantry Battalion 328 Kostrad Cilodong demonstrate good foot hygiene practices and Tinea Pedis was identified in those 24 soldiers. There was a significant relationship between maintaining foot hygiene and the incidence of Tinea pedis ($p=0.026$; OR 2.178), despite maintaining good foot hygiene, certain soldiers were still developed by Tinea pedis. Conclusion: The level of personal foot hygiene, in conjunction with extended use of occlusive footwear, predispose individuals—particularly military personnel—to excessive moisture, interdigital occlusion, maceration, and overgrowth of bacterial flora. These changes in the microenvironment of the feet significantly elevate the risk of Tinea pedis infection.

Keywords: Foot Hygiene, Tinea Pedis, Military Personnel

1. Introduction

The skin, as the outermost anatomical element of the human body, serves as the primary organ with an approximate mass of 5 kilograms and a surface area of about two square meters (Gitleman, 2014). The epidermis also functions as a protective shield, playing an essential role in mitigating disturbances and threats that may penetrate through the skin barrier (Indri M. Riwu Djata et al., 2022). Skin health is influenced by the surrounding environmental conditions. In addition to environmental factors, the implementation of clean and healthy lifestyle behaviors

(PHBS) can also act as a potential trigger for the emergence of skin health problems (Indri M. Riwu Djata et al., 2022).

Indonesia, being a tropical country with a hot and humid climate, presents an environment that—when coupled with poor personal hygiene—can increase the risk of fungal skin infections (Hidayat, 2018). Tinea pedis, commonly known as athlete's foot, is a fungal infection of the skin on the lower foot, compromising the integrity of the skin in that area (Yunia Tasya Wanda, 2022). Generally, Tinea pedis most commonly presents between the fourth and fifth toes, and may spread to the undersides of the toes and other interdigital spaces. It is often characterized by maceration, appearing as fragile, white skin (Gitleman, 2014).

Many workers in Indonesia tend to wear closed footwear for extended periods, often accompanied by a lack of proper foot hygiene (Harlim et al., 2023). One notable example includes members of the Indonesian National Armed Forces (TNI), who are at high risk of developing Tinea pedis due to their involvement in activities that require tight footwear and socks worn for long durations. This is supported by findings from a study conducted on Mobile Brigade Corps (Brimob) personnel in Makassar, where Tinea pedis was detected in 24.35% of the participants (Hadi, 2020).

Based on these facts, the researcher intends to conduct a study to examine the correlation between the level of personal hygiene and the incidence of Tinea pedis among TNI soldiers in the Infantry Battalion Para Raider 328 Kostrad, located in Cilodong. This study is based on the observation that their training routines involve prolonged use of occlusive footwear and exposure to damp field conditions, which collectively contribute to increased vulnerability to health issues, including skin infections.

2. Methods

2.1. Subject Characteristics

This study was conducted on 70 TNI Soldiers of Batalyon Infantri Para Raider 328 Kostrad Cilodong, determined by measuring the Slovin formula to ensure adequate representation of the target population. The participants were categorized by established scoring system (questionnaire) based on the level of personal foot hygiene into good and poor groups, and categorized based on the incidence of Tinea Pedis among soldiers of Batalyon Infantri Para Raider 328 Kostrad Cilodong. Skin scrapings were collected from the toe web spaces and plantar surfaces of the soldiers' feet as part of the data collection process. The specimens were subjected to direct microscopic analysis using 10% potassium hydroxide to identify fungal pathogens associated with *Tinea pedis*. The demographic characteristics of the research respondents can be seen in Table 1.

Table 1: Characteristics of Research Respondents

No.	Characteristics	N	%
1.	Level of Foot Personal Hygiene		
	Good	32	45,7
	Poor	38	54,3
	Total	70	100,0
2.	Incidence of Tinea Pedis		
	Present	24	34,3
	Absent	46	65,7
	Total	70	100,0

Based on Table 1 above, it is known based on the level of foot personal hygiene, the majority of respondents exhibited 54.3% (38 respondents) demonstrated poor foot hygiene maintenance, whereas only 45.7% (32 respondents) maintained adequate hygiene levels. Based on the incidence of Tinea Pedis, Tinea pedis was absent in 46 respondents (65.7%) and present in 24 respondents (34.3%).

2.2. Validity Test

This study assessed the content validity of an eight-item questionnaire administered to a sample of 70 respondents. Several items were adapted from previously validated questionnaires with slight modifications. Item validity was evaluated using Pearson correlation, while reliability was measured using Cronbach's Alpha in SPSS version 27, as shown in Table 2.

Table 2: Questionnaire Validity Analysis Results

The Questionnaire	r-value	r-table	Remarks
P1	0,499	0,2352	Valid
P2	0,410	0,2352	Valid
P3	0,767	0,2352	Valid
P4	0,499	0,2352	Valid
P5	0,299	0,2352	Valid
P6	0,366	0,2352	Valid
P7	0,377	0,2352	Valid
P8	0,505	0,2352	Valid

Table 2 shows the analysis revealed that all items related to housing density demonstrated significant correlations ($p = 0.001$; $p < 0.05$). Given a critical r-value of 0.2352 ($n = 70$; $\alpha = 0.05$), all items had correlation coefficients exceeding this threshold. With a sample size of 70 and two variables, the critical r-value at the 5% significance level was 0.2352. An item was deemed valid if its Pearson correlation coefficient (r-calculated) was greater than the critical r-value.

2.3. Reliability Test

The results of the reliability test for this questionnaire can be seen in Table 3 below.

Table 3: Questionnaire Reliability Analysis

Number of Questions	Cronbach's alpha	Remarks
10	0,759	Reliabel

Table 3 shows the reliability test of the foot hygiene maintenance questionnaire resulted in a Cronbach's Alpha value of 0.759, exceeding the acceptable threshold of 0.60. Therefore, the instrument indicates acceptable internal consistency and is thus considered reliable for use in this study.

These findings suggest that the instrument is both valid and reliable for use in the current research context.

2.4. Pearson Correlation Test

This analysis aimed to assess the association between personal hygiene practices and the incidence of Tinea Pedis among Indonesian Army personnel. The outcomes are displayed in the Table 4 below.

Table 4: Correlation Between Foot Hygiene and The Incidence of Tinea Pedis

		Incidence of Tinea Pedis						p <i>chi-square</i>	OR (95% CI)
		Present		Absent		Total			
		n	%	n	%	n	%		
Personal Foot Hygiene	Good	14	43,8	18	56,2	32	100,0	0,026	2,178 (0,798-5,947)
	Poor	10	26,3	28	73,7	38	100,0		
Total		24	34,3	46	65,7	70	100,0		

Table 4 revealed that 14 respondents (43.8%) with good foot hygiene did not develop Tinea pedis, whereas 10 respondents (26.3%) with poor foot hygiene were diagnosed with the condition. Statistical analysis demonstrated a significant association between foot hygiene practices and the incidence of Tinea pedis ($p = 0.026$; OR = 2.178; 95% CI: 0.798–5.947).

3. Result and Discussion

The primary purpose of the skin is to ensure the survival of the individual. Structurally, Skin was composed of two primary layers—the epidermis and the dermis—the skin plays a central role in protecting the body and maintaining homeostasis. Additionally, the skin includes a subcutaneous layer located beneath the dermis, although it is not considered an integral part of the skin's structure (G. J. Tortora and B. Derrickson, 2017). It has five separate layers: the basal layer, the stratum spinosum (sweat layer), the stratum granulosum, and the stratum corneum (Roy et al., 2018).

Fungal infections of the skin, particularly those affecting the feet—commonly referred to as *Tinea pedis*—tend to have a high prevalence in tropical climates and among individuals who regularly wear closed footwear and pay limited attention to foot hygiene, such as farmers, laundry workers, and military personnel. *Tinea pedis* typically presents around the ankles, between the toes, or on the soles of the feet (Yunia, 2022). According to Zebua (2023), the two most clinically significant variants of this fungal infection are the interdigital and moccasin types (Zebua, 2023). The interdigital type is characterized by macerated, erythematous lesions between the toes, often accompanied by itching, which may lead to secondary complications such as onychomycosis. In contrast, the moccasin variant involves widespread scaling and erythema across the entire plantar surface of the foot (Amalia, 2020).

This study was conducted to determine the effectiveness of using moisturizers with saccharide isomerase content on skin hydration. The moisturizer in this research treatment was given for 7 days and then measured for the difference in skin hydration before and after treatment. A skin hydration examination was carried out using a precision digital skin analyzer.

The study findings revealed that the majority of respondents, including 73.3%, were 19 years old. Additionally, 20.0% of the respondents were 20 years old, while 6.7% were 18 years old. Multiple studies have documented that these skin biophysical characteristics exhibit variations based on age, gender, anatomical area, and season within diverse ethnic communities. The inflection point of this curve becomes apparent at the age of thirty, indicating a more uniform and luminous complexion, enhanced hydration, and a reduced pH level. The skin serves as the primary protective layer, rendering it susceptible to the harmful effects of sunlight, air pollution, and climatic variations. These environmental variables expedite the manifestation of aging in the skin, particularly photoaging induced by ultraviolet (UV) radiation. The advancement of technology has led to the availability of numerous non-invasive instruments for assessing the physiological characteristics of the skin. The commonly utilized parameters include the hydration level of the outermost layer of the skin (stratum corneum), the amount of water lost through the skin (transdermal water loss), the content of sebum (an oily substance produced by the skin), the level of melanin (a pigment responsible for skin color), the level of erythema (redness of the skin), the color system of the skin, and the pH value of the skin surface. Research (Pan et al., 2020) indicates that the cheeks exhibit the highest level of brightness and lightness, with the lowest concentration of sebum. In contrast, the chin has a significantly

deeper shade, while the forehead tends to have a yellowish hue. The skin parameters of TEWL, sebum content, and melanin and erythema indices have a direct correlation with age, displaying a linear relationship. On the other hand, the skin hydration value, ITA, and pH demonstrate a non-monotonic relationship with age. Conversely, as age increases, the expression of aquaporin decreases. Aquaporins, also known as AQPs, are a group of water channels that facilitate the movement of water and tiny molecules to maintain fluid balance in the body. Aquaporins (AQPs) are found in a wide range of species, such as bacteria and humans. Thirteen members of the AQP family have been discovered in humans (AQP0-12), and they are found in different organs. Recently, it has been acknowledged that deviations in the levels of AQPs expression can lead to a range of illnesses (Pan et al., 2020; Ikarashi et al., 2017). In this study, the study population and sample were young adults with a small age gap. This can minimize the occurrence of bias and control the age variable as a confounding variable.

The study findings indicated that the majority of respondents were male, specifically 9 respondents (60.0%), whereas 6 respondents were female (40.0%). The variation in population size can be attributed to the factors of hydration, transepidermal water loss, sebum production, microcirculation, pigmentation, and skin thickness. These factors tend to be higher in men, whereas women generally have higher skin pH levels. Understanding the disparities in skin characteristics associated with gender can aid in the strategic design and creation of gender-specific goods, enabling more tailored dermatological treatments and cosmetic interventions. Sex-related disparities exist in the anatomical, physiological, epidemiological, and symptomatic aspects of certain diseases. Regarding skin illnesses, there is a higher incidence of infectious diseases in men, whereas psychological issues, pigmentation abnormalities, specific hair conditions, and autoimmune and allergy diseases are more commonly observed in women. Conversely, women experience a higher prevalence of sex-related skin illnesses, and the occurrence and outcome of some skin cancers are linked to sex-related disparities. The precise mechanisms responsible for the disparities in skin diseases between sexes remain mostly unidentified. These variances may be influenced by sex hormones, behavioral characteristics, ethnicity, and environmental variations (Rahrovan et al., 2018). Circulating hormones have a significant impact on the disparities between male and female facial skin. Oestrogen mostly affects the skin of women, while androgens, such as testosterone and 5 α -dihydrotestosterone (DHT), primarily influence the skin of men. Oestrogen has advantageous protective effects on the skin by promoting the synthesis of collagen and the creation of elastic fibers and hyaluronic acid. Oestrogen has been demonstrated to enhance the skin's ability to bind water and regulate local inflammation, granulation, and re-epithelialization processes. As a result, it improves the integrity of the skin barrier and enhances its capacity to heal wounds. Testosterone increases the thickness of the tissue that surrounds the dermal and epidermal layers of the skin, which helps in the creation of collagen. While both males and females generate sebum, the elevated amounts of testosterone in males lead to a more substantial production, resulting in generally consistent sebum production levels as they grow older. Both positive and negative effects are on men's skin. Heightened sebum production aids in the assimilation of oils for skin hydration, but it also exacerbates acne and imparts a sticky or oily sensation to the skin while causing the pores to appear enlarged and more prominent (Sikora et al., 2021; Wang et al., 2017).

The results showed the average skin hydration levels of the right upper arm before treatment was $38.67 \pm 6.53\%$ and after treatment was $42.93 \pm 11.67\%$, the left arm before treatment was $37.93 \pm 7.32\%$ and after treatment $39.93 \pm 12.64\%$, the right lower limb before treatment was $23.67 \pm 10.53\%$ and after treatment $35.73 \pm 15.20\%$, and the left lower limb before treatment was $22.87 \pm 10.82\%$ and after treatment was $33.33 \pm 16.11\%$. The results of this study show that the right and left lower limbs have the greatest difference in mean skin hydration before and after treatment, namely $12.07 \pm 14.87\%$ and $10.47 \pm 18.58\%$, respectively. The results of this study are in accordance with research (Dewi & Pangkahila, 2022), which shows the mean skin hydration before and after treatment of the upper arm 28.47 ± 4.80 to 71.30 ± 10.79 ; the forearm 26.63 ± 2.68 to 63.93 ± 9.24 ; the upper limb 24.20 ± 5.72 to 60.60 ± 14.71 ; and the lower limb 22.00 ± 2.13 to $41.57 \pm 6.95\%$, respectively (Dewi & Pangkahila, 2022).

The results of this study showed that there was a significant difference in the mean skin hydration of the right lower limb and left lower limb before and after treatment (p values = 0.007 and 0.047), but the level of skin hydration of the right and left upper arms before and after treatment did not have a significant difference. The results of this study are in accordance with research (Vlorensia et al., 2020), which shows that moisturizing creams containing saccharide isomerate and ceramide effectively increase skin hydration. The average skin hydration after

treatment was 24.46%, with a standard deviation of 3.83 (Vlorensia et al., 2020). The results of this study are in accordance with research (Gougeon et al., 2023) that showed that, compared to the control area, the application of creams, but especially creams containing saccharide isomerate, significantly improved the hydration and glossy properties of the skin on average after 30 minutes. This significant increase ranged from 1.7-fold in the placebo group to 4.6-fold in the cream containing urea (Gougeon et al., 2023). The results of this study are in accordance with research (Dewi & Pangkahila, 2022) showing that using a moisturizer containing saccharide isomerate led to a significant improvement in skin hydration within a 2-week period ($p < 0.05$). Following the discontinuation of the moisturizer, all four sites exhibited notable variations in skin moisture ($p < 0.05$). The study findings indicate that incorporating SI 5% into the moisturizer formulation leads to a significant increase in skin hydration. Furthermore, this enhanced hydration is sustained even after discontinuing the use of the moisturizer, surpassing the effects of standard moisturizers (Dewi & Pangkahila, 2022).

Saccharide isomerate is a naturally occurring, biologically active, and environmentally friendly sugar isomerization agent. This product is created by transforming the sugars found in the edible part of maize, which are primarily glucose, into a distinct combination of carbohydrates that closely resemble the skin. These carbohydrates are similar to the natural moisturizing substances present in the outermost layer of human skin, known as the stratum corneum. Saccharide isomerate is a fully plant-derived compound consisting of complex carbohydrates that closely resemble those naturally present in human skin. This vegan hyaluronic acid booster has demonstrated its capacity to deliver sustained skin hydration by effectively adhering to the skin and limiting the loss of water via the epidermis. Clinical evidence supports the efficacy of saccharide isomerate 1% in delivering both immediate and prolonged hydration. It has the ability to attract and retain water and has previously demonstrated positive effects on the skin's protective barrier, moisture levels, and the microorganisms present on the skin (Martin et al., 2023; Hon et al., 2018). Saccharide isomerate has humectant properties that improve skin hydration (Peltier et al., 2022).

Reduced humidity (reduced water content in the outermost layer of the skin) leads to a decrease in the breakdown of desmosomes. The desmosomes present in the SK sheet undergo digestion, resulting in the separation of the sheet into individual cells when placed in a buffer solution. On the other hand, protease inhibitors added to the buffer solution or heating the sheet stops the desmosomes from breaking down and cells from separating. Leupeptin, or chymostatin, exhibited a cell dissociation slowdown that was only around half as efficient as aprotinin. But when the two substances were mixed together, they stopped the breakdown of the stratum corneum layer just as well as aprotinin did alone. The results support the idea that desmosomes are very important for SK cells to stick together, and that these two types of serine proteases break down desmosomes, which leads to SK desquamation. A decline in trypsin-type protease activity associated with aging was seen in individuals without any health conditions. The amount of moisture in the stratum corneum affects the proteases' ability to break down desmosomes there. According to studies, there are two factors that affect desquamation. The water content of the stratum corneum is one factor to consider. Insufficient water levels impede the optimal functioning of enzymes, regardless of their normal enzyme content. Humectant therapy effectively hydrates the stratum corneum by providing it with water. Another contributing element is a reduction in the enzymatic activity of the protease. This phenomenon is observable in skin that is afflicted with illness or undergoing the natural process of aging (Koyama et al., 1999).

Saccharide isomerate (SI) is a complex carbohydrate mucopolysaccharide (glycan) that closely resembles the one present in the outermost layer of human skin, known as the stratum corneum. Therefore, hyaluronan, or hyaluronic acid, will be produced in the epidermis. In the same way that hyaluronan does, SI can raise the water content of the stratum corneum, which keeps the epidermis moist even when the humidity level is low. SI has the ability to adhere to the skin even in extremely acidic environments (Dewi & Pangkahila, 2022).

The difference in significance between hands and feet may be attributed to differences in anatomical location and exposure to environments that can compromise skin hydration. Research (Mayrovitz et al., 2017) skin hydration, as measured by the tissue dielectric constant (TDC) tool, resulted in values in the forearm proving to be greater than in the leg or foot. In the forearm, there was a monotonous decrease in TDC values ($P < 0.001$) as depth increased, with TDC values at 0.5 mm being 38.4 ± 5.5 and 25.8 ± 4.1 at 5.0 mm depth. At the foot site, a similar

decrease in TDC values was observed from 0.5 mm to 2.5 mm ($P < 0.001$), but the values at 2.5 and 5.0 mm (34.1 ± 6.3 vs. 33.0 ± 12.1) were not significantly different from each other (Mayrovitz et al., 2017).

4. Conclusions

This study demonstrates that the application of a moisturizer containing saccharide isomerate leads to a substantial enhancement in skin hydration among students enrolled in the Faculty of Medicine and Health Sciences at the Republic of Indonesia Defense University. The findings demonstrated a notable disparity in the average skin moisture levels between the right and left lower limbs following the intervention, therefore confirming the efficacy of the moisturizer in augmenting the water content of the outermost layer of the skin, known as the stratum corneum. Furthermore, the research also discovered that incorporating saccharide isomerate into the moisturizer formulation can significantly enhance skin moisture and sustain it even after the cessation of usage, surpassing the effects of conventional moisturizers. This demonstrates the efficacy of including saccharide isomerate in moisturizer formulations to greatly enhance skin hydration. This can be advantageous in addressing dry skin and prolonging skin moisture retention.

Given the results of this study, it is advisable to extend the observation period to a longer duration beyond the current 7-day timeframe in order to further investigate the topic. Extending the study term is anticipated to yield a more comprehensive understanding of the dynamics or alterations that may transpire over an extended timeframe. To enhance the representativeness of the findings, it is imperative to broaden the pool of respondents by incorporating volunteers who mirror the diversity and variability within the community being examined. Therefore, it is anticipated to generate more precise and pertinent results.

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