

Gema Lingkungan Kesehatan

Vol. 23, No. 1 (2025), pp 167-172

e-ISSN 2407-8948 p-ISSN 16933761

Doi: <https://doi.org/10.36568/gelinkes.v23i1.213>

Journal Homepage: <https://gelinkes.poltekkesdepkes-sby.ac.id/>

The Impact of Patient Hygiene on Skin Issues in Lower Limb Prosthesis Users

Nur Rachmat*, Sisybania, Maharani Nadia Andarini

Poltekkes Kemenkes Surakarta, Indonesia, Surakarta, Indonesia

*Correspondence: nurrachmat@gmail.com

ABSTRACT

Amputees require effective support through prostheses, which help restore mobility. Maintaining cleanliness of the stump and prosthesis is essential to prevent skin problems, ensuring comfort during activities. This study aims to determine the relationship between patients' cleanliness levels and skin issues on the stumps of lower limb prosthesis users. This research was conducted in December 2023 at the Community Resource Rehabilitation Development and Training Center (PPRBM) Solo, utilizing the Self-Management Assessment for the Residuum and Prosthesis (S.M.A.R.T) in a cross-sectional observational design. A purposive sampling technique was used to select 40 lower limb prosthesis users. Data analysis involved the Shapiro Wilk normality test and hypothesis testing with Pearson Product Moment. Analysis of the 40 participants revealed a significance value of $p = 0.000$ ($p < 0.05$) and a correlation coefficient of -0.737 . This indicates a significant and strong negative correlation: higher cleanliness levels correspond to fewer skin problems on the stump, while lower cleanliness levels lead to more skin issues. Maintaining a high level of cleanliness is crucial for lower limb prosthesis users to prevent skin issues on the stump.

Keywords: Cleanliness level, Stump skin problems, Health promotion

INTRODUCTION

Amputation, defined as the surgical removal of part or all of a limb, frequently involves the lower extremities, which are classified as above-knee, at-knee, or below-knee amputations (Hobusch et al., 2020). In the rehabilitation process following amputation, prostheses play a vital role in restoring limb functionality and enabling patient mobility. However, the interaction between the skin and the prosthetic device often results in significant dermatological issues, including irritation, dermatitis, and infections. Studies reveal that approximately 75% of lower-limb prosthesis users encounter skin problems, adversely affecting their quality of life (Davies et al., 2020). Lower limb prosthesis users are particularly prone to skin problems, which hinder their mobility and quality of life. These problems range from mechanical issues (e.g., cysts, calluses, hyperplasia) to allergic reactions (e.g., eczema, dermatitis) and infections (Colgecen et al., 2016). These skin complications are attributed to various factors such as mechanical pressure, friction, and moisture retention at the interface between the skin and the prosthesis. Such conditions foster an environment conducive to bacterial and fungal proliferation, increasing the likelihood of infections. Inadequate attention to the hygiene of the residual limb (stump) and prosthesis further exacerbates these issues, particularly in regions with limited access to healthcare

facilities (Meulenbelt et al., 2011) Buikema & Meyerle (2014) emphasize that maintaining cleanliness of the stump and socket is essential to prevent infections and irritation. Regular prosthesis care, including cleaning and condition checks, is widely recommended (O'Keeffe & Rout, 2019).

Previous studies have underscored the importance of maintaining stump and prosthesis hygiene to prevent skin-related complications. Devi et al. (2018) highlighted that proper prosthesis care, including daily cleaning, routine inspections, and regular consultations with prosthetists, is essential to maintaining the device's functionality. Nevertheless, despite the recognized significance of hygiene practices, there is a lack of epidemiological data directly linking patient hygiene habits to the incidence of skin problems. Inadequate hygiene practices significantly elevate the risk of skin infections in post-amputation patients (Mollee et al., 2021). Majority of amputee patients suffer from skin problems due to insufficient hygiene, particularly among lower-limb prosthesis users (Page et al., 2024). However, much of the existing research lacks a quantitative analysis of the relationship between hygiene levels and the prevalence of skin complications.

The high prevalence of dermatological complications among lower-limb prosthesis users highlights the urgent

need to enhance hygiene practices associated with prosthetic devices. While recent advancements in prosthesis design have introduced breathable materials and antimicrobial linings to address these issues, their adoption remains limited due to cost and accessibility challenges (Burge, 2024). The interplay of mechanical stress, heat accumulation, and moisture at the interface between the skin and prosthesis creates a favourable environment for bacterial and fungal growth, thereby increasing the risk of infections (Tinsley et al., 2024). These issues are particularly pronounced in developing regions, where limited resources impede the implementation of routine maintenance and hygiene protocols. Recent studies underline the importance of patient education and community-driven interventions in bridging hygiene gaps. Evidence suggests that tailored educational initiatives can significantly enhance adherence to prosthesis cleaning practices, reducing the incidence of skin complications (Dingle et al., 2024). Additionally, programs involving healthcare professionals and local support networks have demonstrated effectiveness in fostering sustainable hygiene behaviours. However, the absence of standardized guidelines for hygiene management across varying demographic and geographic contexts remains a significant obstacle. A comprehensive understanding of the interaction between individual behaviours, environmental conditions, and prosthesis design is essential for formulating targeted strategies that improve patient outcomes and overall quality of life.

The frequent daily use of prostheses, reaching 84–95% in some populations (Chadwell et al., 2020), underscores the critical need for effective hygiene practices to minimize mechanical stress and moisture build-up. For instance, (Fatima, 2023) found that 36% of lower-limb amputees experienced skin issues, with over 40% suffering from severe conditions such as ulcers and epidermoid cysts. The limited exploration of the direct relationship between patient hygiene practices and skin complications highlights the need for further research. Most existing studies focus on general prosthesis care without delving into the specific impact of daily hygiene practices on skin health. Addressing this gap is essential, as effective hygiene management could significantly reduce dermatological complications among this population. This study seeks to examine the correlation between patient hygiene practices and the occurrence of skin problems among lower-limb prosthesis users, focusing specifically on individuals served by the Surakarta Community Resource Rehabilitation Development and Training Center. By identifying these patterns, the research aims to provide evidence-based recommendations to enhance prosthesis care practices.

RESEARCH METHODS

This study employed a quantitative method with a cross-sectional observational design. This design was selected as it allows for an efficient evaluation of the relationship between patient hygiene levels (independent

variable) and skin problems on the stump (dependent variable) at a single point in time without direct intervention. The study was conducted between January to March 2024 at the Community-Resourced Rehabilitation Development and Training Center (PPRBM) in Solo, located at Jalan Sumatra no. 4A, Ketelan, Banjarsari Subdistrict, Surakarta City, Central Java. The study population comprised all lower limb prosthesis users registered at PPRBM Solo, totaling 40 individuals. A total sampling technique was utilized, including all members of the population who met the inclusion criteria. Inclusion criteria required participants to have used a prosthesis for more than six months, be over 18 years old, and provide informed consent to participate. Participants with a history of unrelated skin diseases or incomplete questionnaire responses were excluded from the study.

Data collection was performed using the Self-Management Assessment for the Residuum and Prosthesis (S.M.A.R.T.) questionnaire, which has been previously validated. The questionnaire consisted of two main sections: patient hygiene levels, assessed through 44 items, and stump skin problems, assessed through 16 items. Each item was scored as Yes (2 points), No (1 point), or Not Sure (0 points). Before completing the questionnaire, participants were informed about the purpose and procedure of the study and were required to sign an informed consent form. Data processing involved several steps, including editing to ensure data completeness and accuracy, coding to assign numerical values to responses, and scoring to calculate the total scores for each variable. Data analysis was conducted, The Shapiro-Wilk Test was employed to assess data normality, and Pearson Product Moment correlation analysis was performed to determine the relationship between patient hygiene levels and stump skin problems, with statistical significance set at $p\text{-value} < 0.05$. Ethical approval for this study was obtained from the Health Research Ethics Committee of Dr. Moewardi General Hospital Surakarta No. 136 / I / HREC / 2024. All research procedures adhered to the principles of research ethics, including respect for participant autonomy, data confidentiality, and minimizing risks to participants. Participants were given the freedom to withdraw from the study at any time without consequences, and their personal data were guaranteed to remain confidential.

RESULTS AND DISCUSSION

Distribution based on research subject characteristics

Table 1 illustrates the distribution of characteristics among research subjects, with 70% male ($n = 28$) and 30% female ($n = 12$). The majority of participants (47.5%, $n = 19$) were aged 41 to 60 years. In terms of education, 40% ($n = 16$) had completed junior high school or equivalent. A significant portion of the subjects worked in the private sector (50%, $n = 20$), and 75% ($n = 30$) used below-knee (trans tibial) prostheses. Lower limb amputations account for 85%–90% of all

amputations, with below-knee amputations being the most common surgical procedure (Rachmat & Kuncoro, 2022). Users of trans tibial prostheses are more likely to experience skin problems due to bony prominences that create higher pressure areas (Belovs & Lannan, 2024).

Table 1.

Characteristics of Respondents

Category	Subcategory	Frequency (n)	Percentage (%)
Age	31-40	8	20.0
	41-50	19	47.5
	51-60	10	25.0
	61-70	3	7.5
Gender	Male	28	70.0
	Female	12	30.0
Address	Karanganyar	3	7.5
	Klaten	1	2.5
	Solo	9	22.5
	Sragen	7	17.5
	Sukoharjo	16	40.0
	Wonogiri	4	10.0
Occupation	Unemployed	12	30.0
	Private Sector	20	50.0
	Entrepreneur	8	20.0
Education Level	No formal education	3	7.5
	Primary School	1	2.5
	Junior High School	16	40.0
	Senior High School	15	37.5
	Higher Education	5	12.5
	Prosthesis Type	Above Knee	4
Knee Disarticulation		5	12.5
Below Knee		30	75.0
Hip		1	2.5
Disarticulation			

Using the Self-Management Assessment for the Residuum and Prosthesis (S.M.A.R.T) questionnaire, the study assessed the frequency of stump and prosthesis cleaning and the occurrence of skin problems. As shown in the table 2, the results indicated that 37.5% (n = 15) of users reported never cleaning their stumps and prostheses, while 15% (n = 6) cleaned rarely, 20% (n = 8) often, and 27.5% (n = 11) always. Notably, 97.5% (n = 39) cleaned their stumps daily, with 67.5% (n = 27) using water and antibacterial soap. These findings confirm that most lower limb prosthesis users are implementing hygiene practices to prevent skin issues. Cleaning with warm water and antibacterial soap can significantly reduce the risk of irritation and infection (Corona et al., 2024). Among the 40 participants, 42.5% (n = 17) reported rarely experiencing skin problems. However, 57.5% (n = 23) experienced mild pain or discomfort when using the prosthesis, often associated with wearing the prosthesis for less than one year. Studies indicate that the risk of pain or injury

increases 3-6 months post-amputation, potentially leading to chronic pain without appropriate treatment (List et al., 2021).

Table 2.

Stump and Prosthesis Hygiene and Skin Problems

Category	Frequency	Frequency (n)	Percentage (%)
Stump and Prosthesis Hygiene	Never	6	15.0
	Rarely	8	20.0
	Often	15	37.5
	Always	11	27.5
Skin Problems on Stump	Never	10	25.0
	Rarely	17	42.5
	Often	13	32.5

Stump socks are critical prosthesis components that must remain clean, as they are in direct contact with the skin (Charkovskij et al., 2022). Proper stump and prosthesis care, including correct wearing practices, can prevent skin problems (Pitkin, 2015). Daily care is essential to mitigate symptoms arising from infections and irritations (Lee et al., 2021). Continuous contact of the stump with the prosthesis can facilitate the growth of microorganisms (Turner et al., 2022). The Shapiro-Wilk normality test results indicated that both patient hygiene level (0.052) and stump skin problem variables (0.260) were normally distributed as shown in table 3.

Table 3.

Normality Test Results

Variable	Shapiro-Wilk Statistic (p)
Patient Hygiene Level	0.052
Skin Problems on Stump	0.260

The hypothesis test using the Pearson Product Moment revealed a significant relationship between cleanliness and the occurrence of skin problems, with a p-value of 0.000 ($p < 0.05$) and a correlation coefficient of -0.737 as shown in table 4. This strong negative correlation suggests that higher cleanliness levels correspond to fewer skin problems.

Table 4.

Correlation Analysis

Variable	Pearson Correlation	p-value	Significance
Hygiene Level vs. Skin Problems	-0.737	0.000	Significant ($p < 0.01$)

This research demonstrates that lower limb prosthesis users with good hygiene practices rarely experience skin problems. In contrast, those with poor hygiene frequently encounter issues. Poor patient hygiene is the primary factor contributing to stump skin

problems, with over 80% of skin issues in amputees attributed to inadequate cleanliness. Excess moisture can also exacerbate skin conditions. To prevent skin problems, stump socks and liners must be kept clean and dry. Daily washing and changing of stump socks are essential to avoid bacterial buildup. Cleaning with antibacterial soap and disinfectants can effectively inhibit the growth of harmful microorganisms. This research proves that if lower limb prosthesis users have a high or good level of cleanliness, they will rarely or never experience skin problems on their stumps, and conversely, if lower limb prosthesis users have a low or poor level of cleanliness, they will experience skin problems more often. on the stump. The main factor in stump skin problems is poor patient hygiene (Turner et al., 2022). More than 80% of skin problems occur in amputee patients who use a prosthesis because they do not pay attention to the cleanliness of the prosthesis (Aflatooni et al., 2024). Dampness can be exacerbated due to the skin of the stump being covered with the socket prosthesis (Choo et al., 2022). Stump care for amputee patients, especially prosthesis users, must be very careful every day to prevent symptoms from arising because of infection and irritation (Lovegreen et al., 2021). Infection of the stump can occur because microorganisms such as bacteria, fungi and germs can multiply well in the skin of the stump where the prosthesis is worn continuously (Baumann et al., 2023). Some components of the prosthesis, such as socks and liners, are components that come into direct contact with the skin. Stump socks are a component of a prosthesis that must be considered clean and its material because it is in direct contact with the skin (George & George, 2021). Providing distal padding in the socket prosthesis can help distribute pressure so that the soft tissue does not directly touch the surface of the socket. Providing distal padding must be done by ensuring the stump is dry to prevent excess moisture (Verzella et al., 2023). The prosthesis should not be worn unless the stump is completely dry, and the stump socks must be washed or changed every day so as not to cause a buildup of bacteria and germs to avoid skin problems (Knight et al., 2022). This is also in accordance with research which states that to prevent the growth of bacteria and germs, socks stumps and liners can be cleaned with antibacterial soap and disinfectants (Büyükakıncı & Döşler, 2020).

This study underscores the critical relationship between hygiene practices and the occurrence of skin problems among lower limb prosthesis users. The findings reveal that a higher level of cleanliness is significantly associated with a reduced incidence of skin complications, highlighted by a p-value of 0.000 and a strong negative correlation coefficient of -0.737. This suggests that maintaining cleanliness can play a substantial role in preventing dermatological issues, aligning with findings from existing literature that emphasizes the importance of hygiene in mitigating complications among amputees (Meulenbelt et al., 2006). Comparative analysis with previous research indicates

that skin problems among prosthesis users remain prevalent. Previous study reported that 80% of amputees face dermatological issues primarily due to inadequate hygiene practices (Keszler, Wright, et al., 2020). In our study, 57.5% of participants reported mild discomfort, indicating that while most users engage in hygiene efforts, challenges persist, particularly among those who have recently begun using prosthetics. This is consistent with findings which document increased skin complications within the first-year post-amputation, emphasizing the need for targeted interventions during this critical period (Keszler, Crandell, et al., 2020).

The practical implications of our findings are substantial. There is a pressing need for the development of comprehensive hygiene guidelines specifically designed for prosthesis users. The results indicate that regular cleaning of the stump and prosthesis with antibacterial soap is essential. Health practitioners should emphasize daily washing, ensuring the stump is thoroughly dried before prosthesis application, and regularly changing stump socks to prevent bacterial accumulation (Wang et al., 2022). Furthermore, education plays a pivotal role. Healthcare providers must prioritize the dissemination of information regarding the significance of hygiene. Providing patients with accessible educational resources, such as instructional pamphlets or workshops on proper stump care, could significantly enhance adherence to hygiene practices. This proactive approach not only fosters better health outcomes but also improves the overall quality of life for amputees (Amudhan et al., 2022).

CONCLUSIONS

This study confirms a significant relationship between cleanliness levels and the occurrence of skin problems in prosthesis users, with a significance value of 0.000 (<0.05) and a correlation strength of -0.737. These results indicate that improved hygiene practices are associated with a reduction in skin complications. The findings underscore the importance of implementing effective hygiene guidelines for prosthesis users. Practical recommendations include daily cleaning routines, proper drying techniques, and regular changing of stump socks to minimize bacterial accumulation. Future research should explore larger and more diverse populations to validate these findings further. Additionally, investigating the psychological factors influencing adherence to hygiene practices can provide valuable insights for enhancing patient care and support strategies.

RECOMMENDATION

Based on the observations and conclusions of this study, it is recommended to develop comprehensive hygiene guidelines tailored to prosthesis users, emphasizing daily cleaning routines, proper drying techniques, and the use of antibacterial solutions. Community-based interventions and educational programs, including workshops and instructional materials, should be implemented to raise awareness

about proper stump and prosthesis care. Additionally, innovative prosthetic designs that enhance air circulation and reduce moisture retention are needed to minimize skin complications. Policymakers should ensure access to hygiene products for underserved populations, while further research should focus on psychological and behavioral barriers to hygiene adherence, as well as the long-term impact of hygiene practices on skin health and overall quality of life. Finally, integrating multidisciplinary care involving dermatologists, prosthetists, and rehabilitation specialists can holistically address the needs of prosthesis users.

REFERENCES

- Aflatoon, S., Beekman, K., Hennessy, K., Highsmith, M. J., Heckman, J. T., Shumaker, P. R., Hivnor, C. M., & Beachkofsky, T. M. (2024). Dermatologic Conditions Following Limb Loss. *Physical Medicine and Rehabilitation Clinics of North America*, 35(4), 739–755. [[Crossref](#)], [[Publisher](#)]
- Amudhan, K., Vasanthanathan, A., & Anish Jafrin Thilak, J. (2022). An insight into Transfemoral Prostheses: Materials, modelling, simulation, fabrication, testing, clinical evaluation and performance perspectives. *Expert Review of Medical Devices*, 19(2), 123–140. [[Crossref](#)], [[Publisher](#)]
- Baumann, M., Price, C., Brousseau, L., Loftsgaarden, M., Powell, J., Sanders, J., & Childers, W. L. (2023). The relationship between residual limb health, motion within the socket, and prosthetic suspension. *PM&R*, 15(4), 510–521. [[Crossref](#)], [[Publisher](#)]
- Belovs, L., & Lannan, F. M. (2024). Dermatologic Conditions in Persons with Lower Limb Amputations: a Review. *Current Physical Medicine and Rehabilitation Reports*, 12(1), 11–18. [[Crossref](#)], [[Publisher](#)]
- Buikema, K. E. S., & Meyerle, J. H. (2014). Amputation stump: Privileged harbor for infections, tumors, and immune disorders. *Clinics in Dermatology*, 32(5), 670–677. [[Crossref](#)], [[Publisher](#)]
- Burge, T. L. (2024). *Designing Multimedia and 3D-Printed Models to Engage Patients Considering Osseointegration*. [[Publisher](#)]
- Büyükkakıncı, B. Y., & Döşler, S. (2020). Antimicrobial socks for orthosis-prosthesis users. *Bulletin of Biotechnology*, 1(2), 52–55. [[Publisher](#)]
- Chadwell, A., Diment, L., Micó-Amigo, M., Morgado Ramírez, D. Z., Dickinson, A., Granat, M., Kenney, L., Kheng, S., Sobuh, M., Ssekitooleko, R., & Worsley, P. (2020). Technology for monitoring everyday prosthesis use: A systematic review. *Journal of NeuroEngineering and Rehabilitation*, 17(1), 1–26. [[Crossref](#)], [[Publisher](#)]
- Charkovskij, A., Bykouski, D., & Samoilov, D. (2022). Development of the lower limb stump prosthetic sock. *AIP Conference Proceedings*, 2430(1). [[Crossref](#)], [[Publisher](#)]
- Choo, Y. J., Kim, D. H., & Chang, M. C. (2022). Amputation stump management: A narrative review. *World Journal of Clinical Cases*, 10(13), 3981. [[Crossref](#)], [[Publisher](#)]
- Colgecen, E., Korkmaz, M., Ozyurt, K., Mermerkaya, U., & Kader, C. (2016). A clinical evaluation of skin disorders of lower limb amputation sites. *International Journal of Dermatology*, 55(4), 468–472. [[Crossref](#)], [[Publisher](#)]
- Corona, P. S., Vargas Meouchi, E. A., García Hernández, J. M., Soriano, R. F., Crespo-Fresno, A., Issa-Benítez, D., Mudaris, M. al, & Soldado, F. (2024). Single-stage transcutaneous osseointegrated prosthesis for above-knee amputations including an antibiotic-loaded hydrogel. Preliminary results of a new surgical protocol. *Injury*, 55(4), 111424. [[Crossref](#)], [[Publisher](#)]
- Davies, K. C., McGrath, M., Savage, Z., Stenson, A., Moser, D., & Zahedi, S. (2020). Using perforated liners to combat the detrimental effects of excessive sweating in lower limb prosthesis users. *Canadian Prosthetics and Orthotics Journal*, 3(2). [[Crossref](#)], [[Publisher](#)]
- Devi, M., Santi, M., Politeknik, R., Kementarian, K., Surakarta, K., & Prostetik, J. O. (2018). Gambaran Body Image Pasien Pasca Amputasi Transtibial Setelah Menggunakan Transtibial Prosthesis. *Jurnal Keterampilan Fisik*, 3(2), 89–99. [[Crossref](#)], [[Publisher](#)]
- Dingle, A. M., Torres, E. B., Brant, J. A., & Adewole, D. O. (2024). Editorial: Neural interfaces for sensory input. *Frontiers in Neuroscience*, 18, 1515353. [[Crossref](#)], [[Publisher](#)]
- Fatima, S. Z. (2023). Life of an amputee: predictors of quality of life after lower limb amputation. *Wiener Medizinische Wochenschrift*, 173(13–14), 329–333. [[Crossref](#)], [[Publisher](#)]
- George, N. M., & George, O. T. (2021). Warty Lesion Over Amputated Stump. *Journal of Skin and Stem Cell* 2021 8:2, 8(2). [[Crossref](#)], [[Publisher](#)]
- Hobusch, G. M., Döring, K., Brånemark, R., & Windhager, R. (2020). Advanced techniques in amputation surgery and prosthetic technology in the lower extremity. *EFORT Open Reviews*, 5(10), 724–741. [[Crossref](#)], [[Publisher](#)]
- Keszler, M. S., Crandell, D. M., & Morgenroth, D. C. (2020). Rehabilitation of Individuals with Limb Loss due to Trauma. *Current Trauma Reports*, 6(2), 96–104. [[Crossref](#)], [[Publisher](#)]
- Keszler, M. S., Wright, K. S., Miranda, A., & Hopkins, M. S. (2020). Multidisciplinary Amputation Team Management of Individuals with Limb Loss. *Current Physical Medicine and Rehabilitation Reports*, 8(3), 118–126. [[Crossref](#)], [[Publisher](#)]
- Knight, A. D., Hendershot, B. D., Sleeman, T. J., Dearth, C. L., Schneider, U., Koehler-McNicholas, S. R., Barrons, K., Nickel, E., Mion, S., Ferguson, J., Starker, F., Slater, B. S., Voss, G. O., Koester, K., & Hansen, A. H. (2022). Toward improving residual limb climate within prostheses for persons with lower limb loss: a technical note. *Prosthetics and*

- Orthotics International*, 46(2), 202–205. [[Crossref](#)], [[Publisher](#)]
- Lee, D. J., Repole, T., Taussig, E., Edwards, S., Misegades, J., Guerra, J., & Lisle, A. (2021). Self-Management in Persons with Limb Loss: A Systematic Review. *Canadian Prosthetics & Orthotics Journal*, 4(1), 35098. [[Crossref](#)], [[Publisher](#)]
- List, E. B., Krijgh, D. D., Martin, E., & Coert, J. H. (2021). Prevalence of residual limb pain and symptomatic neuromas after lower extremity amputation: A systematic review and meta-Analysis. *Pain*, 162(7), 1906–1913. [[Crossref](#)], [[Publisher](#)]
- Lovegreen, W., Murphy, D. P., Stevens, P. M., Seo, Y. I. L., & Webster, J. B. (2021). Lower Limb Amputation and Gait. *Braddom's Physical Medicine and Rehabilitation*, 174-208.e3. [[Crossref](#)], [[Publisher](#)]
- Meulenbelt, H. E. J., Dijkstra, P. U., Jonkman, M. F., & Geertzen, J. H. B. (2006). Skin problems in lower limb amputees: A systematic review. *Disability and Rehabilitation*, 28(10), 603–608. [[Crossref](#)], [[Publisher](#)]
- Meulenbelt, H. E. J., Geertzen, J. H. B., Jonkman, M. F., & Dijkstra, P. U. (2011). Skin Problems of the Stump in Lower Limb Amputees: 1. A Clinical Study. *Acta Dermato-Venereologica*, 91(2), 173–177. [[Crossref](#)], [[Publisher](#)]
- Mollee, T. S., Dijkstra, P. U., Dekker, R., & Geertzen, J. H. B. (2021). The association between body mass index and skin problems in persons with a lower limb amputation: an observational study. *BMC Musculoskeletal Disorders*, 22(1), 769. [[Crossref](#)], [[Publisher](#)]
- O'Keeffe, B., & Rout, S. (2019). Prosthetic rehabilitation in the lower limb. In *Indian Journal of Plastic Surgery* (Vol. 52, Issue 1, pp. 134–144). Georg Thieme Verlag. [[Crossref](#)], [[Publisher](#)]
- Page, B. J., Sheridan, G. A., Greenstein, M. D., Hoellwarth, J. S., Reif, T. J., & Rozbruch, S. R. (2024). PLUS-M Mobility Values of Osseointegration Patients: How do Osseointegration Limb Replacement Prosthesis Users Compare to Traditional Socket Amputee Prosthesis Users? *American Journal of Physical Medicine and Rehabilitation*. [[Crossref](#)], [[Publisher](#)]
- Pitkin, M. (2015). Prosthetic restoration and rehabilitation of the upper and lower extremity. *Prosthetics & Orthotics International*, 39(5), 429. [[Crossref](#)], [[Publisher](#)]
- Rachmat, N., & Kuncoro, B. (2022). Effect Of Use Of Flexible Transfemoral Prosthesis On Level Of Independence In Performing Daily Activities Of Transfemoral Amputee. *Jurnal Keterapian Fisik*, 7(2), 1–9. [[Crossref](#)], [[Publisher](#)]
- Tinsley, J., Carpenter, R. D., Vandenberg, N. W., Stoneback, J. W., & Gaffney, B. M. M. (2024). *Estimating Temporal Bone-Implant Stresses in Patients with Bone-Anchored Lower Limbs*. [[Crossref](#)], [[Publisher](#)]
- Turner, S., Belsi, A., & McGregor, A. H. (2022). Issues faced by people with amputation(s) during lower limb prosthetic rehabilitation: A thematic analysis. *Prosthetics and Orthotics International*, 46(1), 61–67. [[Crossref](#)], [[Publisher](#)]
- Verzella, A. N., Alfonso, A. R., & Chiu, E. (2023). Science and practicality of tissue products in limb salvage. *Functional Limb Salvage: The Multidisciplinary Team Approach*, 305–327. [[Crossref](#)], [[Publisher](#)]
- Wang, M., Nong, Q., Liu, Y., & Yu, H. (2022). Design of lower limb prosthetic sockets: a review. *Expert Review of Medical Devices*, 19(1), 63–73. [[Crossref](#)], [[Publisher](#)]