an idea health journal
ISSN (online): 2797-0604

Effectiveness of Combined Modern Dressing, Infrared, and Ozone Therapy on Diabetic Wound Healing: A Quasi-Experimental Study

Volume 6 No 2, Page 280-289

Asni Hasaini [*1], **Muhlisoh**[2]
[1*]Bachelor of Nursing Study Program, Sekolah Tinggi Ilmu Kesehatan Intan Martapura, Indonesia
[2] Nurse Profession Program, Sekolah Tinggi Ilmu Kesehatan Intan Martapura, Indonesia

Article Info:
Received:19 February, 2026
Revised: 31 March,2026
Accepted:01 April, 2026

Correspondence Author:
Asni Hasaini. Sekolah Tinggi Ilmu Kesehatan Intan Martapura.
70614.
Email:
asnihasaini@gmail.com

How to Cite: Hasaini A, Muhlisoh M. Effectiveness of Combined Modern Deressing, Infrared, and Ozone Therapy on Diabetic Wound Healing: A Quasy-Eksperimental Study. An Idea Health Journal.2026;6(02): 280-289.https://doi.org/10.53690/ihj.v6i02.664

Abstract

Background: Diabetic ulcers are a long-standing problem of diabetes mellitus; in most cases, healing is challenging because of hyperglycemia, vasculopathy, or infection. The objective of this trial is to compare the therapeutic efficacy of a combination of modern dressings, infrared therapy, and ozone treatment with that of the conventional method in diabetic wounds.

Methods: In terms of research design, a non-equivalent pretest-posttest quasi-experimental one-group/three-stage comparison was utilized. The sample included 30 participants, divided into two groups: 15 in the intervention group (modern dressing combined with infrared and ozone) and the rest in the control group receiving only modern dressing. Wound closure was assessed by the Bates-Jensen Wound Assessment Tool (BJAWT). The Wilcoxon and Mann-Whitney tests were used for statistical analysis.

Results: The difference was significant in the intervention group but not in the control group. The between-group difference was also significant, with a medium effect size (0.715). The combined use of therapy exerted a synergistic effect, attributed to the preservation of wound moisture, the improvement of tissue perfusion and oxygenation, as well as a decline in bacterial count.

Conclusion: It was suggested that integrating modern dressings, infrared, and ozone approaches can significantly promote tissue re-regulation in diabetic ulcer patients and should be considered a supplement therapy in wound nursing decisions.

Keywords: Modern Dressing, Ozone Therapy, Diabetes Mellitus

BACKGROUND

In clinical terms, diabetes is divided into two types: type 1 and type 2. Type 1 diabetes mellitus (DM) arises from the autoimmune destruction of insulin-secreting β cells in the islets of Langerhans of the pancreas and is characterized by an absolute deficiency. In contrast, type 2 diabetes mellitus is characterized by impaired insulin secretion and insulin resistance, often linked to obesity, and is defined as a relative deficiency (1). The IDF (International Diabetes Federation) estimates that 537 million adults (20-79 years old) worldwide have diabetes mellitus, representing 10.5% of the global population. The prevalence of T2DM in 2030 is projected to be 643 million (11.3%) and will increase to 783 million (12.2%) by 2045 (2). Indonesia ranks fifth out of the 10 countries with the highest prevalence of diabetes, with 19.5 million people living with diabetes in 2021, and this number is projected to increase to 28.6 million by 2025. Diabetes is a complex metabolic disease that impacts over 340 million individuals, and approximately 20% of them suffer from diabetic wounds worldwide (3).

Injury is a general term that refers to any change in the normal structure or function of any anatomical part. Wounds may vary from minor damage of the skin epithelium to damage of deeper skin tissue with extension to subcutaneous tissue, and potential damage to tendons, muscles, blood vessels, nerves, as well as parenchymal organs or bones. Clinically, wounds are categorized as acute or chronic. Acute wounds typically undergo a relatively rapid healing phase. Wounds that take longer than 12 weeks to heal after the initial injury are classified as chronic wounds, often resulting from prolonged pathological inflammation (4).

Wound healing is sometimes classified as primary healing and secondary healing. The healing of uninfected and uncomplicated wounds is defined as primary healing. Surgical wounds are the best example of primary healing. If the wound-healing process is disrupted by infection, dehiscence, hypoxia, or immune dysfunction, it is classified as secondary healing. Secondary wounds are more susceptible to infection and poor healing (4). Cutaneous injuries, which include diabetic ulcers, are one of the serious complications that frequently occur in DM patients. Persistent hyperglycemia affects both the vascular and peripheral nervous systems, impairing tissue renewal and retarding wound healing. Furthermore, wounds deteriorate due to bacterial infections and poor blood flow, as well as treatment failure due to antibiotic resistance. Efforts are already in place for cutaneous wound care (diabetic foot ulcers) (5).

Modern dressmaking approaches are increasingly replacing conventional methods. Contemporary dressings, such as foam dressings, hydrocolloids, hydrogels, film dressings, and alginate dressings, are prescribed to maintain an appropriate moist environment (moist wound healing), provide thermal insulation, absorb excess exudate, and protect the wound from bacterial contamination (6). These features have been demonstrated to establish an optimal milieu for mediators of epithelialization, angiogenesis, and granulation tissue deposition. Some types of dressings can even be combined with antimicrobial agents to prevent secondary infections and accelerate tissue regeneration (7).

The structure and function of the skin can be disrupted due to lesions that, in some cases, exceed its regenerative capacity. Diabetic foot wounds are often difficult to heal and tend to have a low healing rate. Therefore, the development of innovative and efficient wound care is necessary. The discovery of infrared light for health is ongoing, and it is believed to aid and enhance wound healing (8,9). Wound care using infrared light is proposed as an alternative bioactive approach to support wound healing. Low-level photothermal and photodynamic infrared light can support tissue proliferation and angiogenesis, while maximal photothermal and photodynamic effects can kill bacteria in wounds (10,11) . Additionally, based on clinical evidence and systematic reviews, infrared (IR) therapy also has positive effects on the healing of chronic wounds, including diabetic ulcers, and locally on the intestines. Research on infrared shows positive effects on local blood perfusion, fibroblast proliferation, and granulation tissue formation (7). The same applies to ozone therapy, which, according to some evidence, can reduce bacterial counts in wounds, increase tissue oxygenation, and support accelerated healing. In clinical trials, wound-healing rates increased when ozone therapy was combined with standard therapy (12,13).

Despite growing evidence supporting modern dressing, infrared therapy, and ozone therapy individually, there remains a lack of integrated studies evaluating the synergistic effects of these three interventions when combined. Furthermore, existing studies are often descriptive or combined with other modalities, and are rarely conducted in community-based nursing practice settings, particularly in Indonesia.

This study offers novelty by systematically combining three therapeutic approaches: modern dressing, infrared therapy, and ozone therapy into a single integrated intervention model. Unlike previous studies, this research specifically evaluates their synergistic effects on diabetic wound healing within an independent nursing practice setting, providing a more realistic representation of community-based care. The hypothesis is that the combination of modern dressings, infrared therapy, and ozone therapy is more effective than standard wound care at accelerating wound healing in patients with diabetes mellitus. Based on the description above, researchers are interested in whether the combination of modern dressings, infrared therapy, and ozone therapy is more effective than standard wound care at accelerating wound healing in patients with diabetes mellitus.

METHODS

Study Design

This study employed a quasi-experimental design with a non-equivalent control group and a pretest–posttest design. The study involved two groups: an intervention group and a control group. The independent variable was the combination of modern dressing, infrared therapy, and ozone therapy, while the dependent variable was wound-healing in patients with diabetic ulcers. Potential confounding variables included age, comorbidities, blood glucose levels, body mass index (BMI), smoking status, and medication use.

Setting and Participants

The sample consisted of 30 respondents, divided equally into two groups (n=15 each). According to Borg and Gall (14), determining the sample size for this study requires a sample of 15-30 respondents per group, specifically for experimental and comparative research. The intervention group received a combination therapy consisting of modern dressing, infrared therapy, and ozone therapy, while the control group received standard care using modern dressing only. The sampling technique used was purposive sampling based on predefined inclusion and exclusion criteria. The inclusion criteria were: (1) willingness to participate in the study, (2) patients with grade III–IV diabetic ulcers based on the Wagner Classification, (3) patients undergoing wound care procedures, and (4) fully conscious (compos mentis). The exclusion criteria included: (1) patients with no improvement in wound condition after three consecutive treatments, (2) patients in the proliferation phase of wound healing, (3) patients using alternative wound treatments, and (4) pregnant or breastfeeding women.

Data Collection

Data collection was conducted at baseline (pretest) and after 21 days of intervention (posttest). The intervention protocol was standardized. Infrared therapy was administered using a 250-watt tungsten lamp positioned at a distance of 30 cm from the wound area, with a perpendicular angle based on Lambert's cosine law to optimize radiation absorption. The exposure duration was 5 minutes, and skin temperature was monitored with a thermometer to ensure it did not exceed 42°C. Ozone therapy was administered prior to the application of modern dressings, followed by standardized wound care procedures.

Data Analysis

Wound-healing outcomes were measured using the Bates-Jensen Wound Assessment Tool, a validated instrument for assessing wound status and progression. Data analysis was performed using non-parametric statistical tests. The Wilcoxon signed-rank test was used to analyze within-group differences (pretest–posttest), while the Mann–Whitney U test was used to compare differences between the intervention and control groups. A significance level of $p < 0.05$ was applied.

Ethical Considerations

This study received ethical approval from the Ethics Committee of Intan Martapura School of Health Sciences (No. 139/KE/YBIP-SI/XII/2025). The research flowchart can be seen in the image below as follows.

RESULT AND DISCUSSION

Respondent Characteristics

Table 1. Characteristics of respondents (n=30)

Variables	Intervention (n=15)	Control (n=15)	ρ value
BMI (kg/m^2)	19.95±4.49**	19.99±4.58**	0.981*
Age (years)	54.87±5.71**	56±8.61**	0.676*
Duration suffering	2.33±1.05**	2.47±1.12**	0.732*
Glucose levels	214.47±26.09**	217±32.40**	0.806*
Sex			0.273*
Male	6 (40%) #	3 (20%) #	
Female	9 (60%) #	12 (80%) #	
Comorbidities			0.273*
Has a Comorbid Condition	8 (53.3%) #	5 (33.3%) #	
No	7 (46.7%) #	10 (66.7%) #	
Medication drugs			1.000*
Use of antidiabetic drugs	4 (26.7%) #	4 (26.7%) #	
No	11 (73.3%)#	11 (73.3%) #	
Smoking Status			0.456*
Smoking	6 (40%) #	4 (26.7%) #	
Non-smoking	9 (60%) #	11 (73.3%) #	

*Note : #f(%); ** (mean±SD); *(unpaired test)*

Based on the table above, the average BMI for both groups is nearly identical, with 19.95±4.49 kg/m2 in the intervention group and 19.99±4.58 kg/m2 in the control group (ρ value=0.981). The mean age of respondents is approximately 54-56 years, indicating a mature demographic with no significant age gap between groups (ρ = 0.676). Duration of Suffering: On average, respondents have lived with their condition for about 2.3 to 2.4 years (ρ value = 0.732). Baseline glucose levels are high in both groups (214.47 mg/dL vs 217 mg/dL), indicating a population with similar hyperglycemic states (ρ value = 0.806). Females represent the majority in both groups, 60% in the intervention group and 80% in the control group (ρ value = 0.273). Comorbid Conditions 53,3% of the intervention group have comorbidities compared to 33,3% in the control group. Despite the numerical difference, this is not statistically significant (ρ value = 0.273). The use of medication is perfectly balanced between groups, with 26.7% using drugs and 73.3% not using them in both cohorts (ρ value = 1.000). Smoking

Status: Non-smokers comprise the majority of the sample (60% intervention; 73.3% control), with no significant disparity between groups (ρ value = 0.456).

Table 2. Frequency distribution of the wound healing process before and after in the intervention and control groups at the Banjar Regency Independent Nursing Clinic (n=30)

Wound Healing Process	Intervention				Control			
	Pre		Post		Pre		post	
	f	%	f	%	f	%	f	%
Tissue Health	0	0	1	6.7	0	0	0	0
Wound Regeneration	4	26.7	14	93.3	4	26.7	5	33.3
Wound Degeneration	11	73.3	0	0	11	73.3	10	66.7

Based on the table above, it can be concluded that, before the intervention, the majority of respondents' wound-healing process was in the wound degeneration category (73.3%), and after the intervention, it was in the wound regeneration category (93.3%). In the control group, before the intervention, the majority of respondents' wound-healing process was in the wound degeneration category (73.3%), and after the intervention, it remained in that category (66.7%).

Table 3. Results of the Wilcoxon test for wound healing process pre and post in the intervention and control groups at the Independent Nursing Clinic in Banjar Regency (n=30)

Group	N	Positive Rank	Ties	Negative Rank	ρ-value
Intervention	15	0	3	12	<0.001
Control	15	0	14	1	0.317

According to the table above, neither the intervention group nor the control group showed an increase in scores, with both groups maintaining a score of 0. Within the intervention group, 12 respondents exhibited a decrease in their scores following the intervention, while 3 respondents showed no change. In the control group, 1 respondent experienced a decrease in score, and 14 respondents exhibited no change. The intervention group yielded a ρ value less than 0.05 (< 0.001), indicating a statistically significant difference between pre- and post-intervention scores.

Table 4. Results of the Mann-Whitney test for wound healing process pre- and post-intervention in the intervention and control groups at the Banjar Regency Independent Nursing Clinic (n=30)

Group	N	Mean Rank	Z	Mann-Whitney U	ρ-value
Intervention	15	21.13	-3.816	155	<0.001
Control	15	9.87			

Based on the table above, the ρ value is < 0.05 (< 0.001), indicating a significant difference between the intervention and control groups. To determine the practical significance of the research results, the effect size was calculated using rank biserial correlation (r) with the following formula:

$r = \frac{|Z|}{\sqrt{N}}$

Description:
|Z| = standardized test statistic
N = total samples
The calculation of r is as follows :

$r = \frac{|-3.816|}{\sqrt{30}}$

$r = \frac{|3.816|}{5.48}$

$r = 0{,}715$

The r = 0.715 is included in the medium effect category according to Cohen (15).

DISCUSSION

The study results indicate that 60% of participants in the intervention group and 80% of participants in the control group were female. This is consistent with the IDF 2023 report of the International Diabetes Federation (2023), which suggests that the prevalence of diabetes among women is rising, especially in the >50 age category (16). Theoretically, postmenopausal hormonal changes contribute to insulin resistance and glucose metabolism disorders that can slow wound healing (17). Researchers argue that the predominance of female respondents in this study may influence wound-healing dynamics through hormonal factors and peripheral vascular status. Regarding age, the mean (SD) age of the intervention group was 54.87±5.705, and it was 56±8.611 for the control group. This fact demonstrates that the respondent population was mostly middle-aged to elderly, a high-risk group for diabetic ulcer complications. Physiologically, the aging process decreases fibroblast proliferation, angiogenesis, and collagen production (18). The researchers argue that age is an important contributing factor to the slow rate of tissue regeneration in chronic hyperglycemia. Most respondents experienced hyperglycemia, namely 80% in the intervention group and 73.3% in the control group. This fact is highly relevant because chronic hyperglycemia causes endothelial dysfunction, oxidative stress, and peripheral neuropathy, all of which inhibit wound healing. Theoretically, high glucose levels disrupt keratinocyte migration and macrophage activity, prolonging the inflammatory phase (19). Therefore, additional interventions beyond conventional wound care are essential to accelerate healing.

The results of the nutritional status distribution indicate that the majority of respondents were in the thin category (73.3% in the intervention; 66.7% in the control). Malnutrition is known to inhibit protein synthesis and collagen formation, which are important in the wound proliferation phase. In theory, deficiencies in protein and micronutrients, such as zinc and vitamin C, slow epithelialization (20). The researchers argued that respondents' nutritional status was likely an additional risk factor for wound degeneration in the early phase of the study. The results of this study demonstrate a significant improvement in the intervention group, shifting from wound degeneration (73.3%) to regeneration (93.3%). This clinical progression is likely supported by the integration of three distinct modalities. Modern dressings provide a moist environment, which is essential for autolytic debridement and faster epithelial cell migration. Complementary to this, Infrared therapy is suggested to enhance microcirculation through local vasodilation and increased nitric oxide expression, which optimizes tissue oxygenation. Furthermore, Ozone therapy may reduce bacterial load and activate cellular antioxidant systems. While these results indicate a positive trend, it is important to note that the observed "synergistic effect" is based on clinical outcome scores rather than direct cellular or molecular bioassays. This fact indicates that the combination of therapies has a clinically significant effect. According to the *moist wound-healing* theory, *modern dressings* maintain optimal moisture levels, which accelerate epithelial cell migration and angiogenesis (12,21).

Our findings align with several smaller-scale studies, such as Rahmi et al. (2017), which reported improved healing scores with combined infrared and ozone therapies. However, when compared to high-quality systematic reviews, the evidence for these combined modalities remains varied. For instance, recent meta-analyses on photobiomodulation (infrared) emphasize its role in accelerating the proliferation phase, yet high-quality Randomized Controlled Trials (RCTs) often show that the magnitude of effect can vary depending on dosage and radiation duration. Similarly, while ozone therapy has shown efficacy in refractory wounds, its implementation as a standard protocol remains debated in broader clinical guidelines due to a lack of large-scale multicenter trials. This study contributes to the literature by demonstrating the feasibility of this integrated approach in a community-based nursing setting, though more rigorous evidence is needed to confirm its superiority over advanced modern dressings alone (21).

Infrared therapy is known to improve microcirculation by vasodilating blood vessels and increasing tissue perfusion. Studies show that infrared exposure increases nitric oxide expression and improves tissue oxygenation. Theoretically, increased oxygen supply accelerates the proliferation phase and granulation tissue formation (20). Researchers argue that the synergistic effects of infrared with modern dressings contribute to a significant increase in *wound regeneration* in the intervention group. In addition, ozone therapy has antimicrobial effects and improves tissue oxygenation. In addition, O3 can activate the endogenous antioxidant system and enhance cellular metabolism (6,22,23). In diabetic wounds, ozone can also reduce bacterial counts and enhance granulation tissue formation. Therefore, the interplay between contemporary wound dressings, infrared, and ozone relies on synergistic interactions to ensure adequate moisture levels, good perfusion, and infection prevention.

The Wilcoxon test showed a p-value of <0.001 in the intervention group, indicating a significant difference between the pre- and post-intervention conditions. Meanwhile, the control group showed no significant changes ($p=0.317$). This fact reinforces the hypothesis that combination therapy accelerates wound healing. Statistically, these findings indicate that the changes observed were not due to random variation but rather the intervention's actual effect. The Mann-Whitney test showed a significant difference between the intervention and control groups ($p<0.001$), with mean ranks of 21.13 and 9.87, respectively. This fact confirms that there is a meaningful difference in effectiveness between the groups. Clinically, these results show that combination therapy has a greater impact than modern dressing alone. Researchers argue that a multimodal approach is more rational for the management of diabetic ulcers, given their complex, multifactorial pathophysiology (24).

Several limitations must be acknowledged in interpreting these results: Sample Size and Design. The study utilized a relatively small sample of 30 respondents (n=15 per group) and a non-equivalent quasi-experimental design. The lack of true randomization increases the risk of selection bias, as participants were selected through purposive sampling. Confounding Factors: While variables such as age, BMI, and glucose levels were statistically comparable at baseline, other factors, including nutritional intake beyond specific supplements and the exact level of daily physical activity, were not strictly controlled. Duration: The 21-day observation period provides a snapshot of the early healing phase; however, chronic wounds often require longer monitoring to assess full closure and recurrence rates.

The findings of this study are specifically relevant to independent nursing clinics in community settings similar to the Banjar Regency. Due to the specific inclusion criteria focusing on Wagner Grade III–IV ulcers, the results may not be generalizable to patients with mild ulcers or those in acute hospital settings where systemic care protocols differ significantly. Further research using a multicenter RCT design is recommended to validate these findings and establish standardized clinical guidelines.

Based on the result of the effect size, a medium effect category (r = 0.715). The medium effect size supports the hypothesis that the combination of moisture retention (modern dressing), improved perfusion (infrared), and antimicrobial action (ozone) synergistically enhances tissue repair. Scientifically, the combination therapy approach targeting wound moisture, tissue perfusion, and infection control is an evidence-based strategy aligned with chronic wound management recommendations from the (25).

CONCLUSION

The combination of modern dressings, infrared therapy, and ozone provides a synergistic effect that accelerates tissue regeneration in patients with diabetic ulcers. Researchers suggest that this intervention warrants consideration as an additional protocol in wound care practice, particularly for patients with chronic hyperglycemia and vascular risk factors. To consider the combination of modern dressings, infrared therapy, and ozone as a complementary intervention in diabetic wound management, particularly in patients with chronic hyperglycemia and peripheral vascular disorders, the following conditions should be met: the distance between the infrared source and the skin should be 30 cm, the radiation duration should be 5 minutes, and the treatment period should be 21 days.

ACKNOWLEDGMENTS

We would like to express our deepest gratitude and appreciation to all parties who have supported, namely the Sekolah Tinggi Ilmu Kesehatan Intan Martapura, Zainal Care, Rumah Senyum Sehat, who gave permission and facilitated the implementation of the research and all respondents who participated in this research. Therefore, we express our gratitude for the commitment to research efforts and providing unlimited support.

AUTHOR'S CONTRIBUTION STATEMENT

AS was responsible for the study's concept development, data management, formal analysis, research methods, validation, writing the original draft, as well as reviewing and editing. M contributed to the investigation, methodology, data collection, verification, and provided the necessary resources.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest in the writing of this article.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors affirm that no generative AI or AI-assisted technologies were used in the conception, writing, editing, or formatting of this manuscript. It is evident that all content was created exclusively by the authors listed herein, with no involvement of artificial intelligence tools.

FUNDING

The research leading to these results received funding from Yayasan Banjar Insan Prestasi Sekolah Tinggi Ilmu Kesehatan Intan Martapura under Grant Agreement No. 070/014.02/Penelitian/XI/2025.

REFERENCES

1. Atun S, Dedi B, Sitorus R, Badrujamaludin A, Rumahor H. Rancangan Standar Prosedur Operasional Perawatan Ulkus Pedis Diabeticum Grade 3 dan 4. J Keperawatan Silampari. 2022;6(1):206–16. doi: 10.31539/jks.v6i1.4324
2. Indonesian Society of Endocrinology. Pedoman Pengelolaan dan Pencegahan Diabetes Mellitus Tipe 2 di Indonesia 2024. Available from: https://www.devex.com/organizations/indonesian-society-of-endocrinology-perkeni-100863
3. Muhlisoh, Hasaini A. Efektifitas Foot Exercise and Stretches Terhadap Ankle Brachial Index dan HbA1c Pada Penderita DM Tipe 2. Dunia Keperawatan J Keperawatan dan Kesehatan. 2024;12(3). doi: 10.20527/jdk.v12i3.705.
4. Kangal O, Kopitnik NL. Physiology, Wound Healing. Treasure Island (FL): StatPearls Publishing; 2025. Available from: http://www.ncbi.nlm.nih.gov/books/NBK535406/
5. Dawi J, Tumanyan K, Tomas K, Misakyan Y, Gargaloyan A, Gonzalez E, et al. Diabetic Foot Ulcers: Pathophysiology, Immune Dysregulation, and Emerging Therapeutic Strategies. Biomedicines. 2025;1–17. doi: 10.3390/biomedicines13051076.
6. Wen Q, Liu D, Wang X, Zhang Y, Fang S, Qiu X, et al. A systematic review of ozone therapy for treating chronically refractory wounds and ulcers. IWJ. 2022;:853–70. doi: 10.1111/iwj.13687. PMID : 34612569
7. Zhang J, Zhao Y, Zhao X, Zhang J, Jing L. Efficacy and safety of red and infrared light in the adjunctive treatment on diabetic foot ulcers: A systematic review and meta-analysis. Complement Ther Clin Pract. 2024;57. doi: 10.1016/j.ctcp.2024.101906. PMID : 39305794
8. Vaidya R, Kotennavar MS, Patil A V, Benakatti R, Rathod S. Efficacy of low level laser therapy on wound healing in patients with diabetic foot ulcers. 2023;6:1–7.
9. Taha N, Daoud H, Malik T, Shettysowkoor J, Rahman S. The Effects of Low-Level Laser Therapy on Wound Healing and Pain Management in Skin Wounds : A Systematic Review and Meta- Analysis. 2024;16(10). doi: 10.7759/cureus.72542
10. Oyebode O, Houreld NN, Abrahamse H. Photobiomodulation in diabetic wound healing : A review of red and near-infrared wavelength applications. Cell Biochem Funct. 2021:1–17. doi: 10.1002/cbf.3629. PMID: 33870502.
11. Ama F, Purbowati R, Devi E, Rianti D. The Overview of the Effectiveness of Infrared on the Healing Rate of Incision and Burn Wounds in Male White Rats. 2024;5(2):409–14. doi:10.33122/ejeset.v5i2.235
12. Astasio-Picado Á, Babiano AÁ, López-Sánchez M, Lozano RR, Gómez-Martín, Cobos-Moreno P, et al. Use of Ozone Therapy in Diabetic Foot Ulcers. J Pers Med. 2023;13. doi: 10.3390/jpm13101439. PMID: 37888050
13. Rosa FH, Pereira L, Badu S, Eduarda M, Maciel C, Brasil CA, et al. The effectiveness of ozone therapy for diabetic foot treatment : A systematic review Eficácia da ozonioterapia para o tratamento do pé diabético : Uma revisão sistemática La eficacia de la ozonoterapia para el tratamiento del pie diabético : Una revisión. Res Soc Dev. 2022;11(13):1–18.
14. Sembiring T, Irmawati, Sabir M, Tjahyadi I. Buku Ajar Metodologi Penlitian (Teori dan Praktik). Pertama. Dr. Bambang Ismaya, S.Ag., M.Pd. MS, editor. Karawang: CV Saba Jaya Publisher; 2024. 317 p.
15. Loisa J, Lumbu S, Gumolung D, Wira E. Efektivitas Penerapan Media Pembelajaran PhET Terhadap Hasil Belajar Pada Dimensi Kecerdasan Visual Spasial dan Kecerdasan Logis Matematis Materi Termokimia di SMA Negeri 9 Manado. Oxyg J Chem Educ. 2025;7(2):31–9.

16. International Diabetes Federation. IDF Diabetes Atlas (10th ed.). 2023.
17. Kautzky-willer A. Sex differences in type 2 diabetes. Diabetologia. 2023;66:986–1002. doi: 10.1007/s00125-023-05891-x. PMID: 36897358
18. Alzahrani F, Alabeedi F, Luca S, Terra L. What Factors Can Have an Impact on the Wound Healing Process from An Oral Surgery Perspective ? A Review. SVOA Dent. 2024;33–45. doi: 10.58624/SVOADE.2024.05.0167
19. Fauzan Widianto. Pengendalian Gula Darah Sewaktu Melalui Terapi Frez dan Ecata. Jawa Tengah: PT Media Pustaka Indo; 2026.
20. Mulyanto A, Yuwono DK. Gizi yang Tepat pada Penyembuhan Luka. Poltekita J Pengabdi Masy. 2022;3(1). Available from: http://jurnal.poltekkespalu.ac.id/index.php/PJPM Gizi
21. Lazdia W, Said FM, Nambiar N, Hasnita E, Febrina W. Combination of Infrared Therapy , Ozone Therapy, and Olive Oil On Diabetic Foot Ulcer in Agam Health Center. SEEJPH. 2024;XXV:2424–36. doi: 10.70135/seejph.vi.3042
22. Suchin Dhamnaskar, Gobbur N, Koranne M, Vasa D. Prospective Comparative Observational Study of Safety and Ef fi cacy of Topical Ozone Gas Therapy in Healing of Diabetic Foot Ulcers versus Only Conventional Wound Management. Surg J. 2021;7(3):226–36. doi: 10.1055/s-0041-1731447. PMID: 34541314
23. Modena DAO, Ferreira R de C, Froes PM, Rocha KC. Ozone Therapy for Dermatological Conditions : A Systematic Review. J Clin Aesthet Dermatol. 2022;15(5):65–73. PMID: 35642231
24. Kimyaghalam US-SA, Bergman R. Diabetic Foot Ulceration and Complications. Treasure Island (FL): StatPearls; 2025. Available from: http://www.ncbi.nlm.nih.gov/books/NBK499887/
25. Chen RF, Liu KF, Lee SS, Huang SH, Wu YC, Lin YN, et al. Far-infrared therapy accelerates diabetic wound healing via recruitment of tissue angiogenesis in a full-thickness wound healing model in rats. Biomedicines. 2021;9(12):1–11. doi: 10.3390/biomedicines9121922. PMID: 34944737