

THE EFFECT OF MINI ELECTRICAL MUSCLE STIMULATION (EMS MINI MASSAGE) BUTTERFLY ON ELDERLY PATIENTS WITH PARESTHESIA AND SLEEP PATTERN DISTURBANCE

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ABSTRACT

Introduction

Sleep disturbances are a common problem among older adults due to physiological changes associated with aging and the presence of chronic diseases that cause physical discomfort. These conditions can lead to a decline in quality of life, daily activities, and the health status of older adults. To address these issues, one non-pharmacological therapy that can be used is the administration of massage therapy using the butterfly mini Electrical Muscle Stimulation (EMS Mini Massage). This study aims to explore the effects of administering the butterfly mini Electrical Muscle Stimulation (EMS Mini Massage) on elderly individuals with paresthesia and sleep pattern disturbance as a nursing issue.

Method

This study employed a single-case study design involving a 70-year-old elderly individual with paresthesia and sleep pattern disturbance as a nursing issue at the UPTD Griya Wredha Jambangan in Surabaya. The intervention consisted of administering the butterfly-style mini Electrical Muscle Stimulation (EMS Mini Massage) for 7 days, with sleep quality evaluated using the Pittsburgh Sleep Quality Index (PSQI) questionnaire.

Result

The results of the 7-day intervention using the butterfly-shaped mini Electrical Muscle Stimulation (EMS Mini Massage) device showed that the client experienced improved sleep patterns, as indicated by a decrease in the Pittsburgh Sleep Quality Index (PSQI) score from 12 pre-intervention to 8 post-intervention.

Conclusion

There was an improvement in the clients' sleep quality following the gradual administration of the Butterfly Mini Electrical Muscle Stimulation (EMS Mini Massage) intervention, accompanied by a reduction in sensory discomfort. This intervention can serve as a non-pharmacological alternative in geriatric nursing care to improve the quality of life for older adults.

INTRODUCTION

Sleep disorders in older adults are part of a multifaceted geriatric syndrome—a complex and interrelated set of health issues commonly found in the elderly population (Faridho, 2025a). Insomnia and sleep disorders in older adults are associated with increased use of long-term medications, cognitive impairment, decline in sensory function such as vision and hearing loss, depression, behavioral changes, and limitations in performing daily activities requiring instrumental skills (Instrumental Activities of Daily Living) (Kennair *et al.*, 2022). Additionally, reduced sleep quality in the elderly is also linked to a high risk of falls, which can lead to serious injuries such as fractures and mobility impairments (Fitriana, Putri & Darmawati, 2025).

The significant impact of these issues makes sleep disturbances in the elderly a common health problem found in many countries. According to reports, 20% to 50% of older adults experience sleep disorders annually (Sahri & Hasibuan, 2023). The WHO (World Health Organization) states that 25% to 57% of adults and the elderly experience difficulty sleeping each year, with 19% of them suffering from insomnia. In Indonesia, the prevalence of sleep disorders is quite high, reaching approximately 67% in 2020 (WHO, 2020).

The high prevalence of sleep disturbances among older adults is influenced by various factors, such as physiological changes due to the aging process, anxiety, depression, decreased physical function, chronic diseases, pain, and neurological disorders (Ketut *et al.*, 2023). One of the neurological disorders that frequently causes sleep disturbances in the elderly is stroke (Amalia & Amalia, 2021). Post-stroke elderly individuals often experience sleep disturbances due to changes in neurological function, limited mobility, pain, and abnormal sensations in the extremities (Ketut *et al.*, 2023). A common form of sensory disturbance experienced by post-stroke older adults is paresthesia (Meliniawati *et al.*, 2024). Paresthesia is an abnormal sensation characterized by tingling, numbness, a pricking sensation, or loss of sensation resulting from nerve dysfunction (Indonesian Ministry of Health, 2022). Complaints of paresthesia generally appear or worsen at night when the body is at rest, causing discomfort, difficulty falling asleep, frequent nighttime awakenings, and reduced sleep quality in the elderly (Farhad, 2025). This is caused by the circadian rhythm

at night, which makes the body more sensitive to pain, subsequently leading to an increase in symptoms (Khan, 2026). If this occurs continuously, the condition can result in reduced physical activity, disrupt daily activities, and lead to inadequate sleep quality (Azhari, 2026)

METHOD

This study employed a single-case study design. The research was conducted at the UPTD Griya Wredha Jambangan in Surabaya from November 14 to 21, 2025. The study subject was a 70-year-old elderly individual presenting with complaints of paresthesia and nursing issues related to sleep disturbances. Data collection included interviews (medical history), observation, physical examination, and nursing assessment using the Pittsburgh Sleep Quality Index (PSQI).

The intervention consisted of administering Mini Electrical Muscle Stimulation (EMS Mini Massage) Butterfly therapy twice daily for 10–20 minutes over 7 days in accordance with standard operating procedures. The EMS device was applied to the affected extremities with stimulation intensity adjusted to the client's tolerance. Evaluations were conducted daily to assess changes in sleep duration, nighttime awakenings, comfort levels, sensory complaints, and PSQI scores before and after the intervention.

RESULT

The client complained of tingling and numbness in both lower extremities, especially at night. The client also experienced difficulty falling asleep, frequent awakenings, disrupted sleep patterns, and fatigue during daytime activities. The results of the sleep quality assessment using the Pittsburgh Sleep Quality Index (PSQI) showed a score of 12, indicating poor sleep quality. The client reported frequently waking up due to tingling sensations and discomfort in the legs.

During the seven-day intervention period, the client gradually reported a decrease in tingling sensations and an increase in comfort. Sleep duration increased, and the frequency of waking up at night decreased. The client also stated feeling more relaxed after receiving EMS therapy. Following the

intervention, the PSQI score improved from 12 to 8, indicating better sleep quality. Overall, the client demonstrated a positive response to the intervention, including increased comfort, reduced sensory complaints, and improved sleep patterns.

DISCUSSIONS

The findings of this study indicate that the Butterfly Mini Electrical Muscle Stimulation (EMS Mini Massage) device can improve sleep quality in elderly patients with paresthesia. Sleep disturbances in older adults are generally associated with the aging process and chronic neurological disorders that cause sensory discomfort (Lipsitz *et al.*, 2018). In Mr. Y's case, sleep disturbances were influenced by paresthesia—specifically tingling and numbness in the palms of his hands and soles of his feet—which occurred more frequently at night. This condition caused the client discomfort, hindering the onset of sleep and leading to frequent awakenings. These abnormal sensations at night may be influenced by prolonged static body position, reduced environmental distraction, and neurological disorders resulting from a history of stroke and Parkinson's disease (Tussyah'diyah, 2023). This aligns with the research by Sachau *et al.* (2023), which indicates that sensory disturbances can affect sleep quality by causing discomfort during rest.

The selection of the Butterfly Mini Electrical Muscle Stimulation (EMS Mini Massage) therapy as an intervention was based on the research by Nugraha *et al.* (2021), which noted that EMS is capable of enhancing nerve and muscle stimulation through mild electrical impulses, improving blood circulation, stimulating peripheral nerve activity, and inducing a relaxing effect on the muscles. This finding aligns with research by Agustina (2023), who stated that electrical stimulation is known to increase peripheral nerve activation and help reduce abnormal sensations in the extremities. In this case, massage therapy is considered a supportive intervention because it is relatively safe, easy to perform, and does not cause side effects compared to pharmacological therapy (Septiani, 2025).

The evaluations on the first and second days did not show any significant changes. Changes began to appear on the third day, when the client started to show slight changes in sleep patterns; specifically, the client reported being able to sleep from 7:00 PM to 1:00 AM, though they still woke up frequently but were able to fall back asleep afterward. The client also noted that the sensation from the EMS treatment felt more comfortable on the palms; the numbness in the palms had decreased, though the soles of the feet still felt numb and the paresthesia remained unchanged. Further improvements occurred on the fifth day, marked by the client being able to sleep soundly without waking and the paresthesia gradually subsiding. The client reported being able to sleep from after Isha' until 3:00 AM without waking up. The client also noted that the paresthesia in the palms had disappeared, though they still felt a sensation of heaviness. Regarding the soles of the feet, the client reported no changes and continued to experience paresthesia; on the sixth and seventh days, the client was able to sleep through until morning, though they did wake up briefly for suhoor. The client also stated that the paresthesia in the palms of the hands had disappeared and felt lighter, but on the soles of the feet, the complaints remained the same, namely a tingling and numb sensation.

This condition indicates that the response to therapeutic stimulation varies across different parts of the body, particularly in the lower extremities, where nerve recovery is slower compared to the upper extremities (Indonesian Ministry of Health, 2024). In line with this, Ntranos (2025) states that recovery from neuropathy in the feet can take months to over a year. Generally, improvement begins in the proximal parts or closer to the body and gradually extends to the tips of the toes or fingers.

On the seventh day, the Pittsburgh Sleep Quality Index (PSQI) questionnaire was administered again to assess sleep quality, yielding a score of 8. This result indicates an improvement in sleep quality compared to the PSQI score at the initial assessment, although it is not yet optimal. These findings align with the study by Chang *et al.* (2022), which suggests

that electrical stimulation and relaxation-based therapy can gradually address sleep issues. However, other studies also indicate that massage therapy combined with electrical stimulation tends to provide short-term symptom relief and may not be sustained long-term if not continued consistently (Kopf, 2021). The improvement in the clients' sleep quality in this study was influenced by the short-term effects of the administered therapy. Additionally, the paresthesia in the soles of the feet, which remained a complaint for the clients, also served as a barrier to achieving optimal sleep quality, although improvements were already evident in the palms of the hands.

CONCLUSIONS

Based on the results of the study, it can be concluded that the client with paresthesia and a history of stroke and Parkinson's disease has experienced tingling and numbness in both palms and feet over the past five months, which has led to sleep disturbances characterized by difficulty falling asleep, frequent awakenings at night, less than 5 hours of sleep, dissatisfaction with sleep, and a PSQI score of 12 indicating poor sleep quality. Consequently, a nursing intervention was provided in the form of massage therapy using the Mini Electrical Muscle Stimulation (EMS Mini Massage) Butterfly device for 7 days, administered twice daily, following procedures for identifying contraindications, monitoring therapeutic response, and applying massage to the affected body areas slowly and precisely. The results of the intervention showed gradual improvement in sleep quality and paresthesia complaints, marked by the client being able to sleep for 6 hours by the third day, although she still woke up at night, and a reduction in the sensation of heaviness in her hands; then on the fifth day, the client was able to sleep for 6 hours without waking up and the paresthesia in the palms disappeared, indicating that this therapy can improve sleep patterns and reduce sensory complaints, with a decrease in the PSQI score from 12 to 8 following the intervention.

Future researchers are encouraged to conduct massage therapy interventions using the Butterfly Mini Electrical Muscle Stimulation

(EMS Mini Massage) device for longer durations to assess the effectiveness of EMS, including its long-term effects. Additionally, future researchers may combine EMS therapy with other nonpharmacological interventions, such as distraction or relaxation techniques.

BIBLIOGRAPHY

- Adams, V., 2018, 'Electromyostimulation to fight atrophy and to build muscle: facts and numbers', *Journal of Cachexia, Sarcopenia and Muscle*, 9(4), 631.
- Akbar, F., Darmiati, D., Arfan, F. & Putri, A.A.Z., 2021, 'Pelatihan dan Pendampingan Kader Posyandu Lansia di Kecamatan Wonomulyo', *Jurnal Abdidas*, 2(2), 392–397.
- Alfianto, Y., Sapitri, A., Bella Safira, T., Siti Aisyah, N., Ariyanti, S., Teknologi dan Kesehatan Muhammadiyah Kalimantan Barat, I. & Korespondensi, P., 2026, 'Literatur Review: Analisis Faktor yang Mempengaruhi Kualitas Tidur pada Lansia', *Jurnal Siti Rufaidah*, 4(1), 1–12.
- Alpin, H., 2016, 'Hubungan Fungsi Gerak Sendi dengan Tingkat Kemandirian Lansia di Panti Sosial Tresna Werdha Gau Mabaji Kabupaten Gowa', *JKSHSK*, 1(1), 897–903.
- Alqurashi, H.B., Robinson, K., O'Connor, D., Piasecki, M., Gordon, A.L., Masud, T. & Gladman, J.R.F., 2023, 'The effects of neuromuscular electrical stimulation on hospitalised adults: systematic review and meta-analysis of randomised controlled trials', *Age and Ageing*, 52(12), afad236.
- Amalia, L. & Amalia, L., 2021, 'Gangguan Tidur pada Pasien Stroke Fase Akut', *Jurnal Neuroanestesi Indonesia*, 10(1), 47–54.
- Amin, A.A., Amanati, S., Purnomo, D. & Putra, A.P., 2018, 'Pengaruh Infra Red, Electrical Stimulation dan Terapi Latihan pada Drop Hand et causa Post op Fraktur Humerus', *Jurnal Fisioterapi dan Rehabilitasi*, 2(1), 69–76.
- Arna, Y.D., Kelabora, J., Ranti, I.N., Fione, V.R., Horhoruw, A., Asmanidar, Firdaus, I., Sahalessy, Y., Robert, D., Maimaznah, Sineke, J., Agusrianto, Manueke, I., Faisal, I. & Ezalina, 2024, *Lansia dan*

- Permasalahannya*, Media Pustaka Indo, Cilacap.
- Baylor, C., Yorkston, K., Jensen, M., Truitt, A. & Molton, I., 2024, 'Scoping review of common secondary conditions after stroke and their associations with age and time post stroke', *Topics in stroke rehabilitation*, 21(5), 371–382.
- Berger, J., Ludwig, O., Becker, S., Backfisch, M., Kemmler, W. & Fröhlich, M., 2020, 'Effects of an Impulse Frequency Dependent 10-Week Whole-body Electromyostimulation Training Program on Specific Sport Performance Parameters', *Journal of Sports Science & Medicine*, 19(2), 271.
- Bhagaskara, D.R., Sutejo, M.N., Kwartawaty, N.N. & Sari, D.V., 2025, 'The Effect of a Combination of Hand Therapeutic Exercise and Hand Ball Exercise on Reducing Paresthesia Effects to Improve Functional Activity in the Wrist Area of the Elderly | Jurnal EduHealth', *Jurnal Eduhealth*, 16(4).
- Biology Insights, 2025, *How to Use an Electrical Muscle Stimulation (EMS) Unit*
- Brahlek, A., 2025, *Anxiety and Older Adults: Overcoming Worry and Fear - American Association for Geriatric Psychiatry, AAGP : American Association for Geriatric Psychiatry*.
- Chang, W.D., Tsou, Y.A., Chen, Y.Y. & Hung, B.L., 2022, 'Cranial Electrotherapy Stimulation to Improve the Physiology and Psychology Response, Response-Ability, and Sleep Efficiency in Athletes with Poor Sleep Quality', *International Journal of Environmental Research and Public Health*, 19(4), 1946.
- Chen, L.W., Islam, M.S., Harvey, L.A., Whitehead, N., Hossain, M.S., Rahman, E., Taoheed, F., Urme, N.A. & Glinsky, J. V., 2025, 'Strength training with electrical stimulation has no or little effect on the very weak muscles of patients with spinal cord injury: a randomised trial', *Journal of Physiotherapy*, 71(1), 42–47.
- Cheung, T., Lam, J.Y.T., Fong, K.H., Cheng, C.P.W., Xiang, Y.T. & Li, T.M.H., 2025, 'Efficacy of electrical vestibular stimulation (VeNS) on adults with insomnia: A double-blind, randomized, sham-controlled trial', *Dialogues in Clinical Neuroscience*, 27(1), 236–248.
- Clamiza, Z., Alfianur, Ezalina & Trisnawati, N., 2025, 'Penerapan Stretching untuk Peningkatan Sensitivitas Kaki dan Ankle Brachial Index (ABI) pada Lansia dengan Diabetes Mellitus Tipe II yang Mengalami Parestesia', *Jurnal Keperawatan Muhammadiyah*, 10(2), 2025.
- Dhanyamraju, S., 2024, *Paresthesia: Symptoms, Causes, and Treatment Guide, Lone Star Neurology clinic*.
- Donohue, M., 2021, *What Are the Stages of Aging?, Blue Moon Senior Counseling*.
- Elvina, E., Masfuri, M. & Kariasa, I.M., 2023, 'Manajemen Nonfarmakologis dalam Mengurangi Resiko Konstipasi pada Pasien Ortopedi', *Jurnal Keperawatan Silampari*, 6(2), 1672–1682.
- Emmelia, R., 2017, *Asuhan Keperawatan Gerontik, Pustaka Baru Press*. Farhad, K., 2025, *Why Is Neuropathy Worse at Night? | Mass General Brigham, Mass General Brigham*.
- Faridho, F.R., 2025a, 'Gangguan Tidur Pada Lansia : Tinjauan Pustaka Sistematis', *PREPOTIF : Jurnal Kesehatan Masyarakat*, 9(1), 1482–1492.
- Faridho, F.R., 2025b, 'Gangguan Tidur Pada Lansia : Tinjauan Pustaka Sistematis', *PREPOTIF : Jurnal Kesehatan Masyarakat*, 9(1).
- FDA, 2017, *Electronic Muscle Stimulators | FDA*.
- Ferini-Strambi, L., Rinaldi, F., Giora, E., Marelli, S. & Galbiati, A., 2016, 'REM sleep Behaviour Disorder', *Parkinsonism and Related Disorders*, 22, S69–S72.
- Fitriana, L.A., Putri, M.S. & Darmawati, I., 2025, 'The Relationship Between Sleep Quality And Fall Risk In The Older Adults: Hubungan Kualitas Tidur dengan Risiko Jatuh Pada Lanjut Usia', *Jurnal Keperawatan Widya Gantari Indonesia*, 9(1), 42–48.
- Gobbo, M., Maffiuletti, N.A., Orizio, C. & Minetto, M.A., 2014, 'Muscle motor point identification is essential for optimizing

- neuromuscular electrical stimulation use', *Journal of NeuroEngineering and Rehabilitation*, 11(1), 17.
- Guzmán-González, B., Llanos, P., Calatayud, J., Maffiuletti, N.A. & Cruz- Montecinos, C., 2019, 'Effect of neuromuscular electrical stimulation frequency on postprandial glycemia, current-related discomfort, and muscle soreness. A crossover study', *Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme*, 44(8), 834–839.
- Hardy, E.J., Hatt, J., Doleman, B., Smart, T.F., Piasecki, M., Lund, J.N. & Phillips, B.E., 2022, 'Post-operative electrical muscle stimulation attenuates loss of muscle mass and function following major abdominal surgery in older adults: a split body randomised control trial', *Age and Ageing*, 51(10), afac234.
- Heugten, C.M. van & Wilson, B.A., 2021, 'Cognition, Emotion and Fatigue Post-stroke', *Clinical Pathways in Stroke Rehabilitation: Evidence-based Clinical Practice Recommendations*, 219–242.
- Hooker, D.N. & Prentice, W.E., 2009, *Basic Principles of Electricity and Electrical Stimulating Currents | Therapeutic Modalities in Rehabilitation, 5e | AccessPhysiotherapy | McGraw Hill Medical, Mc Graw Hill : Access Physiotherapy*.
- Huang, J.F., 2017, 'Prevention and Management of Poststroke Complications', *Continuum (Minneapolis, Minn.)*, 23(1, Cerebrovascular Disease), 93–110.
- IEC, 2012, *IEC 60601-2-10 Ed. 2.0 b:2012 – Medical electrical equipment – Part 2-10: Particular requirements for the basic safety and essential performance of nerve and muscle stimulators*.
- Kannan, S., Dutta, A. & Das, A., 2024, 'Sleep disorders in functional neurological disorder – a systematic review and meta-analysis', *Neurological Sciences*, 46(4), 1573.
- Kemendes RI, 2024, *Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/Menkes/1933/2024 Tentang Pedoman Nasional Pelayanan Klinis Tatalaksana Akupuntur Medik*.
- Kementerian Kesehatan Republik Indonesia, 2022, *Parestesia, Kemenkes RI*.
- Kennair, L.E.O., Hagen, R., Hjemdal, O., Havnen, A., Ryum, T. & Solem, S., 2022, 'Depression, Anxiety, Insomnia, and Quality of Life in a Representative Community Sample of Older Adults Living at Home', *Frontiers in Psychology*, 13, 811082.
- Khan, H., 2026, *What causes peripheral neuropathy symptoms to worsen at night?*, *Axiom*.
- Kopf, D., 2021, 'Massage and touch-based therapy : Clinical evidence, neurobiology and applications in older patients with psychiatric symptoms', *Zeitschrift für Gerontologie und Geriatrie*, 54(8), 753–758.
- Lambertsen, K.L., Finsen, B. & Clausen, B.H., 2018, 'Post-stroke inflammation—target or tool for therapy?', *Acta Neuropathologica*, 137(5), 693.
- Lees, T., Shad-Kaneez, F., Simpson, A.M., Nassif, N.T., Lin, Y. & Lal, S., 2018, 'Heart Rate Variability as a Biomarker for Predicting Stroke, Post-stroke Complications and Functionality', *Biomarker Insights*, 13, 1177271918786931.
- Lipsitz, L.A., Manor, B., Habtemariam, D., Iloputaife, I., Zhou, J. & Trivison, T.G., 2018, 'The pace and prognosis of peripheral sensory loss in advanced age: association with gait speed and falls', *BMC Geriatrics* 2018 18:1, 18(1), 274-.
- Manurung, M.E.M., Utami, R.A., Tandilangi, A.A., Maria, D., Kusumaningsih, I., Siregar, N.S.N., Saragih, D., Kurwiyah, N. & Padaunan, E., 2023, *Ilmu Dasar Keperawatan Gerontik*, Yayasan Kita Menulis.
- Mehta, P., Potter, C.A., Feinberg, J.H., Simon, J.H. & Maravilla, K.R., 2024, 'Paresthesias and dysesthesias', *Imaging Acute Neurologic Disease: A Symptom-Based Approach*, 332–346.
- Meliniawati, P.F.S., Yuliadarwati, N.M., Amelia, R.V. & Siddik, M., 2024, 'Penyuluhan Fisioterapi Komunitas Terkait Pencegahan Kesemutan Di Posyandu Lansia Rw 2 Desa Klampok, Singosari', *ABDI KARYA : Pengabdian Kepada Masyarakat*, 1(2), 01–05.

- Miyahara, Y. & Miyahara, Y., 2023, 'The acute effect of therapeutic thiacupressure on foot on freezing of gait in parkinson's disease patients during "on" medication time. a randomized non-inferiority trial.', *Chulalongkorn University Theses and Dissertations (Chula ETD)*.
- Moore, P.A. & Haas, D.A., 2020, 'Paresthesias in Dentistry', *Dental Clinics of North America*, 54(4), 715–730.
- Nokes, B., Baptista, P.M., Apodaca, P.M.R. de, Carrasco-Llatas, M., Fernandez, S., Kotecha, B., Wong, P.Y., Zhang, H., Hassaan, A. & Malhotra, A., 2022, 'Transoral awake state neuromuscular electrical stimulation therapy for mild obstructive sleep apnea', *Sleep and Breathing* 2022 27:2, 27(2), 527–534.
- Novriansyah, R., Hasneli, Y. & Woferst, R., 2022, 'Sarung Tangan Refleksi Manual (SATASIMA) Efektif Menurunkan Gejala Parestesia Tangan pada Pasien Diabetes Mellitus', *Jurnal Ners Indonesia*, 13(1).
- Ntranos, A., 2025, *Can Peripheral Neuropathy Be Reversed? What a Neurologist Wants You to Know*, *Achilles Neurology Clinic*.
- Nugraha, D.A., Hamidah, N.A. & Rachmawati, N.D., 2021, 'Electrical Stimulation dan Passive Exercise Efektif dalam Meningkatkan Kekuatan Otot Pasien Lesi Nervus Radialis', *Physiotherapy Health Science*, 3(2).
- Nugroho, H., Suri, O.I., Utama, D. & Putri, P., 2022, 'Peningkatan Pengetahuan Lansia Mengenai Sulit Tidur pada Lansia dengan Pemberian Pendidikan Kesehatan', *Jurnal Peduli Masyarakat*, 4(2).
- Ohga, S., Hattori, T., Shimo, K., Maeda, H. & Matsubara, T., 2024, 'Impact of electrical muscle stimulation-induced muscle contractions on endogenous pain modulatory system: a quantitative sensory testing evaluation', *BMC Musculoskeletal Disorders* 2024 25:1, 25(1), 1077-.
- Paillard, T., 2018, 'Regular Muscle Electrical Stimulation Could Act Favorably On Bone Mineral Density in Healthy Aged Subjects', *Frontiers in Physiology*, 9.
- Paillard, T., 2022, 'Neuromuscular or Sensory Electrical Stimulation for Reconditioning Motor Output and Postural Balance in Older Subjects?', *Frontiers in Physiology*, 12, 779249.
- Painter, F., 2026, 'Parestesia: Pendekatan Diagnostik Praktis', *American Family Physician*.
- Patel, P., Green, M., Tram, J., Wang, E., Murphy, M., Abd-Elseyed, A.A. & Chakravarthy, K., 2025, 'Latest Advancements in Transcutaneous Electrical Nerve Stimulation (TENS) and Electronic Muscle Stimulation (EMS): Revisiting an Established Therapy with New Possibilities', *Journal of Pain Research*, 18, 137.
- Patricia, W., 2023, 'Basic geriatric nursing', *Basic Geriatric Nursing*, 8th edn., p. 390, Elsevier/Mosby, India.
- Pernando, Y., 2020, 'Parestesia Expert System! Expert System To Detect Paresthesia (Parestesia Expert System! Sistem Pakar Untuk Mendeteksi Penyakit Parestesia)', *Jurnal KomtekInfo*, 7(3), 186–196.
- Pourdanesh, F., Tabrizi, R., Alam, M., Farzan, Avishan, Moslemi, H., Farzan, Ava, Khorsand, A., Mohammadikhah, M. & Farzan, R., 2024, 'Effect of transcutaneous electrical nerve stimulation on neuro-sensory disturbance after orthognathic surgery: a randomized clinical trial', *Annals of Medicine & Surgery*, 86(9), 5224–5229.
- Purnamasari, I. & Pudang Binoriang, D., 2024, 'Kombinasi Kompres Hangat dan Aromaterapi untuk Mengurangi Nyeri dan Gangguan Tidur Lansia', *Jurnal Riset Daerah*, 24(4), 195–203.
- Putu, F.S.M., Nungki, M.Y. & Ratna, V.A., 2024, 'Community Physiotherapy Counseling Related To Preventing Tingling At The Elderly Posyandu Rw 2, Klampok Village, Singosari', *Jurnal Pengabdian Kepada Masyarakat*, 1(2).
- Rachmah, S. & Mujiadi, 2022, *Buku Ajar Keperawatan Gerontik*, STIKES Mojopahit Mojokerto, Mojokerto.
- Riza, A., 2018, 'Permasalahan yang Dialami Lansia dalam Menyesuaikan Diri terhadap Penguasaan Tugas-Tugas Perkembangannya', *ISLAMIC COUNSELING : Jurnal Bimbingan dan Konseling Islam*, 2(2).

- Rydholm, H., Corswant, C. Von, Denison, H., Jensen, J.M., Lehmann, A., Ruth, M., Söderlind, E. & Aurell-Holmberg, A., 2016, 'Reducing Adverse Effects during Drug Development: The Example of Lesogaberan and Paresthesia', *Clinical Therapeutics*, 38(4), 946–960.
- Sachau, J., Kersebaum, D., Hüllemann, P., Adolf, D., Kabelitz, M., Keller, T., Freynhagen, R., Tölle, T.R., Binder, A. & Baron, R., 2023a, 'The association of self-reported symptoms of central sensitization and sleep disturbances in neuropathic pain', *Pain Reports*, 8(5), E1098.
- Sagalajev, B., Zhang, T., Abdollahi, N., Yousefpour, N., Medlock, L., Al-Basha, D., Ribeiro-da-Silva, A., Esteller, R., Ratté, S. & Prescott, S.A., 2024, 'Absence of paresthesia during high-rate spinal cord stimulation reveals importance of synchrony for sensations evoked by electrical stimulation', *Neuron*, 112(3), 404-420.e6.
- Sartoyo, 2024, *Modul Praktikum Massage Terapi*, Fakultas Ilmu Kesehatan ITSK, Malang.
- Sassmann, R., Gampenrieder, S.P., Rieder, F., Johansson, T., Rinnerthaler, G., Castagnaviz, V., Lampl, K., Herfert, J., Kienberger, Y.T., Flamm, M., Schaffler-Schaden, D. & Greil, R., 2024, 'Electrotherapy as treatment for chemotherapy-induced peripheral neuropathy — a randomized controlled trial', *Frontiers in Neurology*, 15, 1451456.
- Setyawan & Baharudin, A., 2022, 'Penatalaksanaan Fisioterapi pada Pasien Stroke Monoparase Superior dengan Infrared (IR), Electrical Myostimulation (EMS), dan Propioceptive Neuromuscular Facilitation (PNF)', *BMC Complementary and Alternative Medicine*, 19(1).
- Shadmehr, E. & Shekarchizade, N., 2025, 'Endodontic periapical lesion-induced mental nerve paresthesia', *Dental Research Journal*, 12(2), 192. Shafa, H.A.F., Soesanto, E. & Ernawati, E., 2022, 'Kejadian Konstipasi pada Lansia di Post Pelayanan Terpadu Lanjut Usia', *Jurnal Keperawatan Tropis Papua*, 5.
- Sheffler, L.R. & Knutson, J.Sc.J., 2006, 'Therapeutic Electrical Stimulation in Neurorehabilitation | Musculoskeletal Key', *Musculoskeletal Key: Fastest Musculoskeletal Insight Engine*, 1, 1703–1706.
- Smit, C.A.J., Berenpas, F., Groot, S. de, Stolwijk-Swuste, J.M. & Janssen, T.W.J., 2020, 'Feasibility of overnight electrical stimulation-induced muscle activation in people with a spinal cord injury. A Pilot study', *Spinal Cord Series and Cases* 2020 6:1, 6(1), 5-.
- Stengel, S. von, Fröhlich, M., Ludwig, O., Eifler, C., Berger, J., Kleinöder, H., Micke, F., Wegener, B., Zinner, C., Mooren, F.C., Teschler, M., Filipovic, A., Müller, S., England, K., Vatter, J., Authenrieth, S., Kohl, M. & Kemmler, W., 2024, 'Revised contraindications for the use of non-medical WB-electromyostimulation. Evidence-based German consensus recommendations', *Frontiers in Sports and Active Living*, 6, 1371723.
- Stepnowsky, C.J. & Ancoli-Israel, S., 2018, 'Sleep and Its Disorders in Seniors', *Sleep medicine clinics*, 3(2), 281.
- Stöllberger, C. & Finsterer, J., 2019, 'Side effects of and contraindications for whole-body electro-myo-stimulation: a viewpoint', *BMJ Open Sport — Exercise Medicine*, 5(1), e000619.
- Suljic, E., Mehicevic, A. & Gavranovic, A., 2023, 'Stroke Emergency Medical Care: Initial Assessment, Risk Factors, Triage and Hospitalization Outcome', *Materia Socio-Medica*, 25(2), 83.
- Suzuki, K., Miyamoto, M. & Hirata, K., 2017, 'Sleep disorders in the elderly: Diagnosis and management', *Journal of General and Family Medicine*, 18(2), 61.
- Syahrani, F.A. & Kurniawati, R., 2020, 'Gangguan Tidur Pada Lansia', *jurnal Ilmiah Kesehatan dan Keperawatan Alkautsar*, 1(1).
- Tim Pokja SDKI DPP PPNI, 2017, *Standar Diagnosis Keperawatan Indonesia*, 1st edn., vol. 3, DPP PPNI, Jakarta.
- Tim Pokja SIKI DPP PPNI, 2018, *Standart Intervensi Keperawatan Indonesia*, 1st edn., vol. 2, DPP PPNI, Jakarta.
- Tim Pokja SLKI DPP PPNI, 2019, *Standar Luaran Keperawatan Indonesia*, 1st edn., vol. 2, DPP PPNI, Jakarta.

- Tran, H.P.T. & Leonard, S.D., 2017, 'Geriatric Assessment for Primary Care Providers', *Primary Care - Clinics in Office Practice*, 44(3), 399–411.
- Unram, J.K., Susilawati, A., Harahap, H.S. & Tiksnadi, A., 2024, 'Peranan Terapi Noninvasive Brain Stimulation rTMS (Repetitive Transmagnetic Stimulation) Pada Proses Pemulihan Pasien Stroke', *Jurnal Kedokteran (Unram Medical Journal)*, 13(1), 6–13.
- WHO, 2025, *Penuaan dan kesehatan*, World Health Organization.
- WHO, 2024, *The top 10 causes of death*, World Health Organization.
- Wiatanti, D., Yolandari, Y., Rihhadatul'aisy, F.J., Jannah, L.N. & Sheba, S.H., 2025, 'Mengenal dan Mencegah Disfagia Melalui Modifikasi Makanan dan Latihan Menelan', *Jurnal Pengabdian Masyarakat (Adi Dharma)*, 4(1), 34–39.
- Wulan, Antoko, A.P. & Santoso, T.B., 2025, 'Pengaruh Dosis Rangsangan Listrik Terhadap Kekuatan Kontraksi Otot Quadriceps Atlet Tenis Lapangan - UMS ETD-db', *INTEGER: Journal of Information Technology*, 10(1).
- Wulandari, S. & Pranata, R., 2024, 'Deskripsi Kualitas Tidur dan Pengaruhnya terhadap Konsentrasi Belajar Mahasiswa', *Jurnal Pendidikan Kesehatan Rekreasi*, 10(1), 101–108.
- Xu, H. & Yin, T., 2024, 'Effective Acupuncture in Treating Decade-Long Occipital Neuralgia in an Elderly Patient', *The American journal of case reports*, 25.
- Yan, J., Zhang, J., Hua, H., Wu, W., Lin, H., Xiong, Q., Jin, J. & Shu, L., 2026, 'EMS hand prop: Leveraging the loss of sense of agency caused by electrical muscle stimulation to make hands serve better as virtual objects', *International Journal of Human-Computer Studies*, 208(1), 103715.
- Yoo, H.J., Park, S., Oh, S., Kang, M., Seo, Y., Kim, B.G. & Lee, S.H., 2023, 'Effects of electrical muscle stimulation on core muscle activation and physical performance in non-athletic adults: A randomized controlled trial', *Medicine*, 102(4), e32765.
- Yuliyanti, I., 2024, 'Studi Kasus : Penerapan Terapi Electrical Muscle Stimulation (EMS) Butterfly Terhadap Kekuatan Otot Pada Atlet Pasca Cedera Akut', *Thesis, Universitas Pendidikan Indonesia*.
- Zhang, C. & Murrell, G.A.C., 2025, 'Prevalence of hand paresthesia and numbness in painful shoulders: a narrative review', *Annals of Joint*, 10(0).