

Physiotherapy Intervention for Carpal Tunnel Syndrome Using Neural Mobilization in Sudan

Marina Napelion¹, Ahmed Banaga², Hassan Abdelnour^{3,4}

¹Faculty of Physiotherapy, Ibn Sina University (ISU), Khartoum, Sudan.

²Faculty of Physiotherapy, Alnilin University (NU), Khartoum, Sudan.

³Faculty of Applied Medical Sciences, Physiotherapy Department, Jerash University (JU), Jerash, Jordan.

⁴School of Health Sciences, Physiotherapy Department, Ahfad University for Women (AUW), Omdurman, Sudan.

Corresponding Author: Hassan Abdelnour.

ORCID ID: <https://orcid.org/0009-0001-9873-5966>

DOI: <https://doi.org/10.5281/zenodo.17464327>

Published Date: 28-October-2025

Abstract: Introduction: Carpal Tunnel Syndrome (CTS) is a collection of symptoms occurs after compression of Median Nerve and the Carpal Tunnel (Sierra-Silvestre *et al*, 2024). Median Nerve mobilization is one of the interventions used in the treatment of CTS (Sierra-Silvestre *et al*, 2024). Several studies reported optimum results with the use of neurodynamic mobilization as a conservative treatment for CTS patients (Sierra-Silvestre *et al*, 2024). The aim of this study was to investigate the effectiveness of the neural mobilization of the median nerve in the management of carpal tunnel syndrome. **Methodology:** The study employed an analytical case control design to facilitate the neural mobilization of the median nerve in physiotherapy clinics located in Khartoum, Sudan. A total of 30 participants diagnosed with CTS took part in the study, which was divided into control and experimental groups, each consisting of 15 participants. Data collection was conducted using questionnaires and a standard data sheet. The analysis of the data was performed using the Special Package for Social Sciences (SPSS) version 21. All ethical considerations for approval and confidentiality have been duly obtained. **Results:** Each control and experimental group exhibited notable differences between pre-treatment and post-treatment, with p-values being less than 0.05. However, no significant differences were observed between the control and experimental groups in this study. **Conclusion:** The application of Ultrasound, Exercise, and Neural Mobilization of the Median Nerve for CTS resulted in a significant positive rehabilitation effect. There were no significant differences found between the control and experimental groups in this research.

Keywords: Neural Mobilization, Carpal Tunnel Syndrome (CTS), Physiotherapy, Symptoms Severity Scale (SSC), Functional Status Scale (FSS), Khartoum, Sudan.

1. INTRODUCTION

In the United States, approximately 2.7 million medical consultations annually are associated with patients reporting symptoms related to their fingers, hands, or wrists (Sanjari *et al*, 2024). The predominant cause of these symptoms is Carpal Tunnel Syndrome (CTS), which represents 90% of all cases of entrapment neuropathies (Urits *et al*, 2019). Carpal Tunnel Syndrome (CTS) can lead to various complications that affect hand functions, including tingling, weakness, pain, and sensory loss. The Carpal Tunnel is a narrow passage located in the wrist on the palm side. The carpal bones and the flexor retinaculum create the roof of this tunnel. These boundaries are quite rigid, resulting in limited stretch capacity within the carpal tunnel, through which the median nerve and nine flexor tendons to the fingers traverse. When pressure is applied to the median nerve, the condition is diagnosed as CTS. The carpal tunnel is a narrow passage located in the wrist on the palm side, measuring approximately one inch in width. It is formed by the carpal bones that create the floor and sides of the

tunnel, while the flexor retinaculum serves as the roof. These boundaries are quite rigid, resulting in limited capacity for stretching within the carpal tunnel (Leo, 2023). The Median Nerve, along with nine flexor tendons that lead to the fingers, traverses through the carpal tunnel (Almalty *et al*, 2025; Leo, 2023).

Physiotherapy treatments are regarded as one of the conservative approaches to managing Carpal Tunnel Syndrome (CTS). Numerous studies have indicated favorable outcomes with the application of neurodynamic mobilization as a conservative treatment for patients suffering from CTS (Sierra-Silvestre *et al*, 2024). Neural Mobilization is one of the physiotherapy methods that has been examined in this research.

Sudan, situated in East North Africa, is regarded as one of the developing nations (Adam *et al*, 2025; Osman *et al*, 2024; Abdelnour *et al*. 2023). The field of physiotherapy within rehabilitation is advancing, albeit facing challenges due to the country's low socioeconomic status, which results in a constrained healthcare system in the area (Abdalmagid *et al*, 2023). Although physiotherapy services commenced in the early 1980s, educational programs for physiotherapy began in 2004 at Ibn Sina University (ISU) followed by Ahfad University for Women (AUW), Alnilin University (AU), and National University (NU) which all located in Khartoum State (Almalty *et al*, 2024). Lately, Master of Science (MSc) program established at AU.

This research was carried out to evaluate the impact of Neural Mobilization on Carpal Tunnel Syndrome (CTS) in Sudan, as there have been no prior similar studies conducted in the country. A limited number of studies have explored physiotherapy methods for Rheumatoid Arthritis (RA) and sports injuries in Sudan (Alkazaleh *et al*, 2024; Osman *et al*, 2024; Abdelnour *et al*. 2023). There was only one study done by Abdelnour *et al* (2025), which discussed the physiotherapy intervention for CTS using neural mobilization.

2. METHODOLOGY

The research was a prospective analytical case-control study aimed at evaluating the neural mobilization of the median nerve. It was carried out in Khartoum, Sudan, encompassing physiotherapy clinics at ISU, Police Hospital, and the Al-Sudani Center for Physiotherapy. All individuals involved in the study were diagnosed with CTS. The study sample comprised 30 cases, which were concurrently divided into two groups: a control group and an experimental group, with 15 patients in each. The control group received treatment through ultrasound and exercises; in contrast, the experimental group was treated with ultrasound, exercises, and neural mobilization of the median nerve. Both groups underwent a total of 12 treatment sessions, with 3 sessions scheduled per week over a duration of four weeks. Ultrasound treatment was administered to both the control and experimental groups three times a week for a duration of four weeks, totaling 12 sessions. The dosage utilized was 1 MHz pulsed ultrasound for 15 minutes per session, with a frequency of 1 Hz, applied to the palmar side of the wrist joint. The exercises included both strengthening and stretching activities for the wrist and fingers. These exercises comprised wrist flexion and extension, finger flexion and extension, finger abduction and adduction, thumb flexion and extension, as well as wrist ulnar and radial deviation. Participants were instructed to perform these exercises 10 times, five times a day. Neural Mobilization of the Median Nerve was applied exclusively to the experimental group. The participant was positioned seated with the shoulder abducted to 90 degrees, maintaining full elbow extension and supination. The mobilization of the median nerve was executed by adjusting the positions of the wrist and neck; during wrist extension, the neck remained in a neutral position, while wrist flexion required the neck to bend to the opposite side. The therapist was positioned in front of the patient to ensure proper execution of the technique. Additionally, participants were advised to continue these exercises at home alongside the other prescribed activities. Assessment was conducted prior to the treatment sessions and upon their conclusion. The Visual Analogue Scale (VAS) was utilized to evaluate pain, while a hand dynamometer was employed to measure hand grip strength. The Boston Carpal Tunnel Questionnaire (BCTQ) was specifically used; the Symptoms Severity Scale (SSS) assessed the severity of Carpal Tunnel Syndrome (CTS), and the Functional Status Scale (FSS) evaluated hand functionality. Data collection was performed through a questionnaire designed to gather demographic information. Data was examined utilizing the Microsoft Excel program and SPSS version 21.0, employing a paired sample T-test to assess the differences in the mean values between the control and experimental groups at a confidence level of 95% and a P-value of 0.05 or less. Consent from all physiotherapy centers has been secured, and written approval was acquired from the participants prior to their involvement in the study. The data were stored on a personal computer protected by a personal password. All participants retained the right to withdraw from the study at any point.

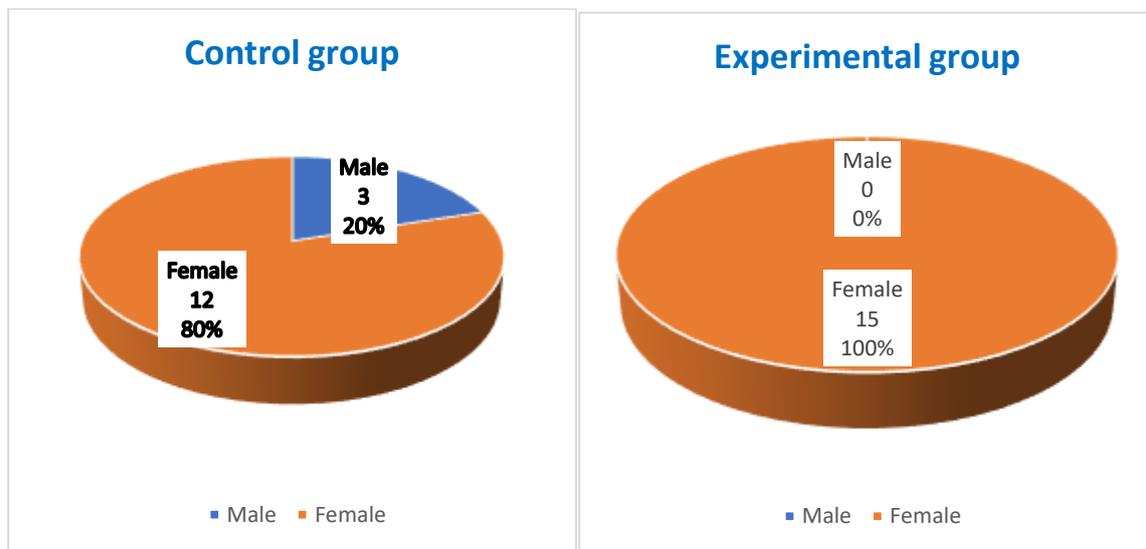
3. RESULTS

Table 4.1: Age and weight in control and experimental groups:

	Number	Minimum	Maximum	Mean
Age	30	24	75	53
Weight	30	47	90	73

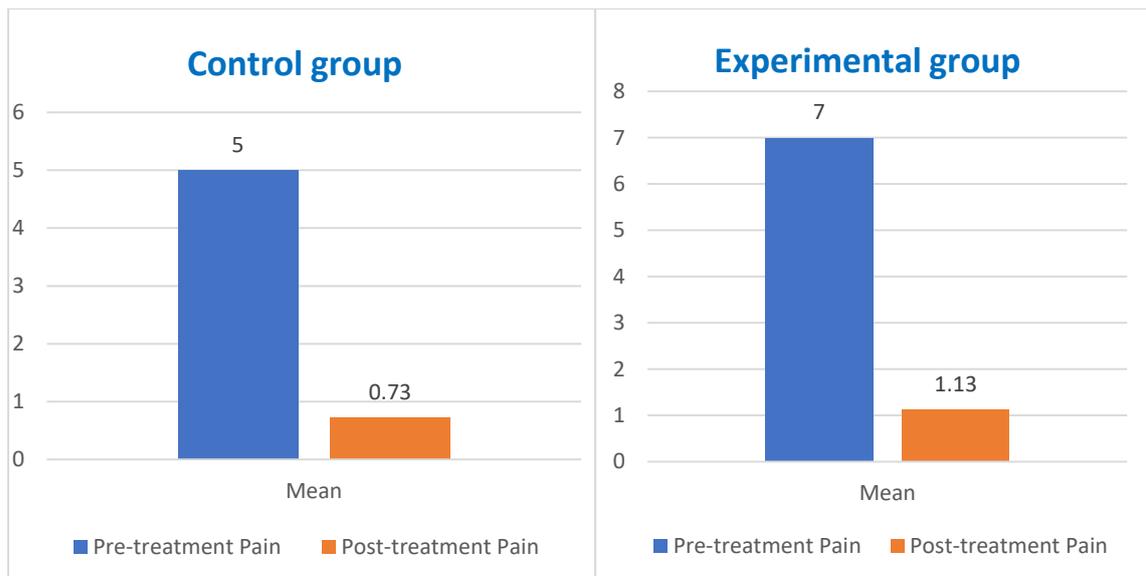
Table 4.1. indicates that the average age in both groups is 53 years, while the average weight in both groups is 73 kg.

Figure 4.1. Gender in control and experimental groups:



In the control group, there were 20% (3 out of 15) males and 80% (12 out of 15) females, whereas the experimental group consisted entirely of females, as illustrated in figure 4.1.

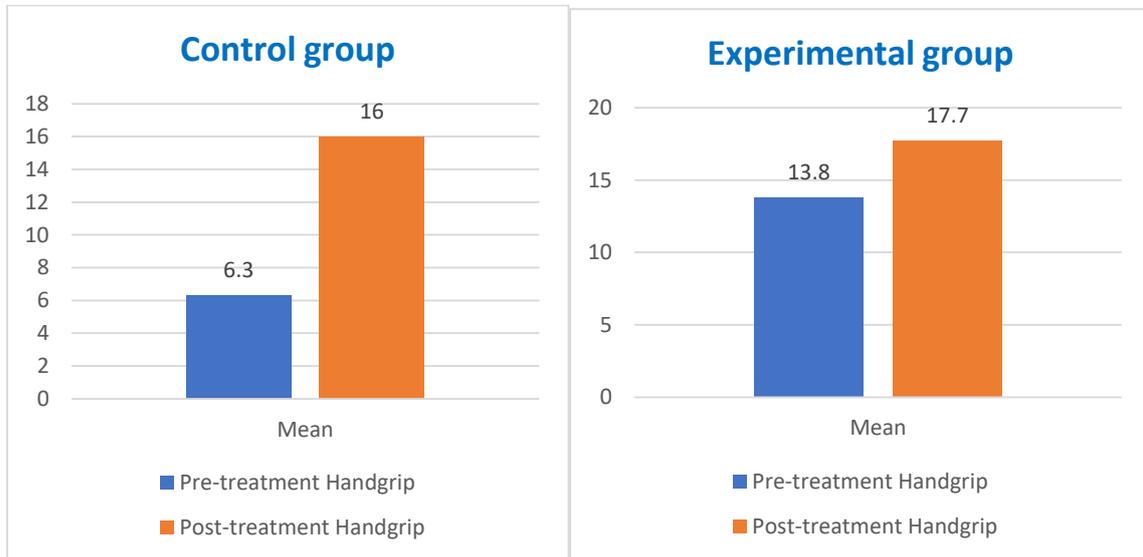
Figure 4.2: Statistical analysis of pre and post treatment of pain in control and experimental groups:



As illustrated in figure 4.2, both groups demonstrated a notable enhancement in pain management before and after treatment. In the control group, the mean score decreased from 5 to 0.73 on the VAS pain scale. This resulted in a significant difference between pre-treatment and post-treatment, with a p-value of (0.000). In the experimental group, the mean score decreased

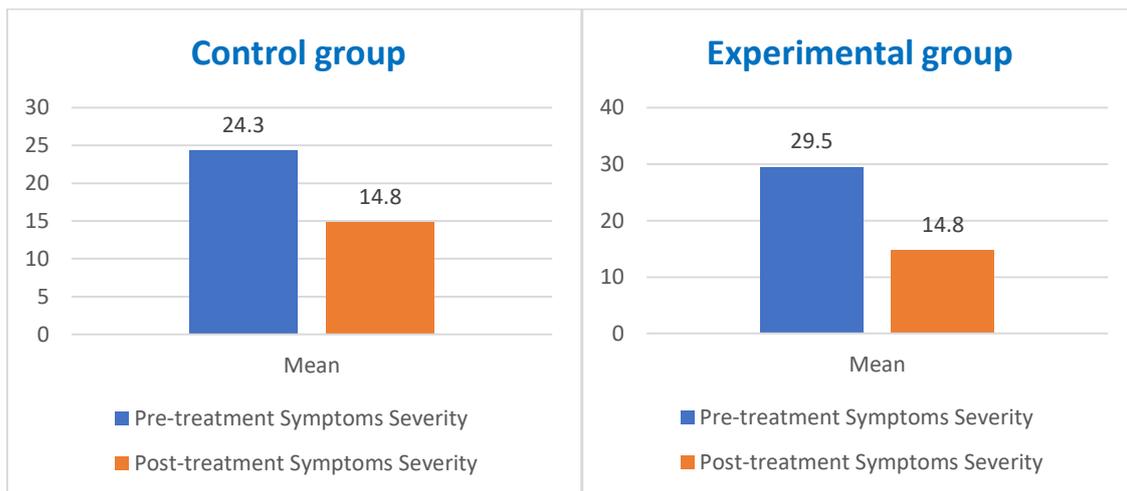
from 7 to 1.13 on the VAS pain scale. This also resulted in a significant difference between pre-treatment and post-treatment, with a p-value of (0.000).

Figure 4.3: Statistical analysis of pre and post treatment of hand grip in control and experimental groups:



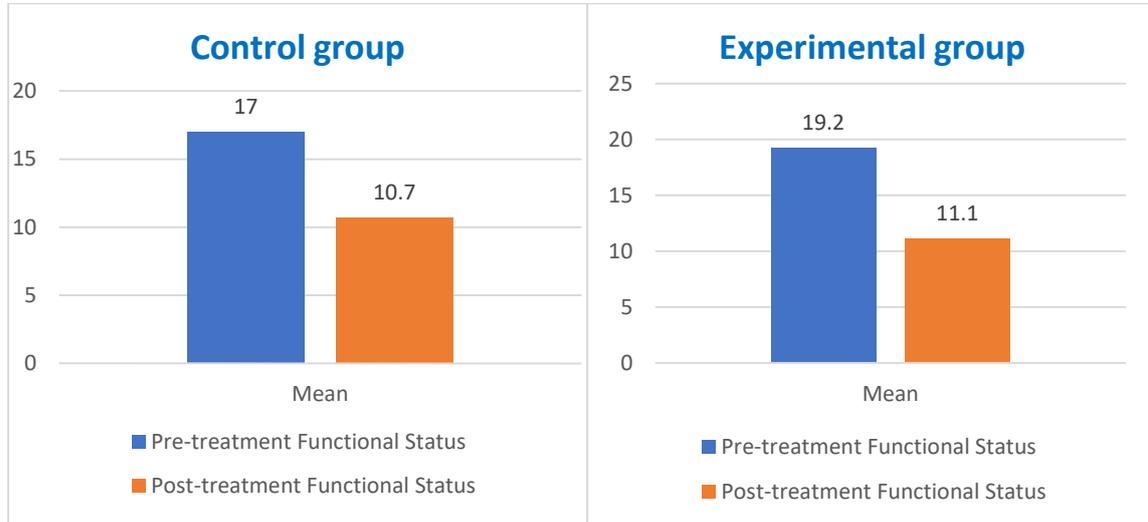
As illustrated in figure 4.3, both groups demonstrated a notable enhancement in hand grip before and after treatment. In the control group, the mean score rose from 6.3 to 16 when measured with a hand dynamometer for hand grip. This resulted in a significant difference between pre and post treatment with a p-value of (0.001). In the experimental group, the mean score increased from 13.8 to 17.7 using the hand dynamometer for hand grip. This also resulted in a significant difference between pre and post treatment with a p-value of (0.048).

Figure 4.4: Statistical analysis of pre and post treatment of Symptom severity scale in control and experimental groups:



As illustrated in figure 4.4, both groups demonstrated a notable improvement in symptom severity before and after treatment. In the control group, the mean score decreased from 24.3 to 14.8, as measured by the SSS for symptom severity. This resulted in a significant difference between pre and post treatment, with a p-value of (0.000). In the experimental group, the mean score decreased from 29.5 to 14.8, also using the SSS for symptom severity. This too resulted in a significant difference between pre and post treatment, with a p-value of (0.000).

Figure 4.5: Statistical analysis of pre and post treatment of functional status scale in control and experimental groups:



As illustrated in figure 4.5, both groups demonstrated a notable enhancement in functional status before and after treatment. In the control group, the mean score decreased from 17 to 10.7, as measured by the FSS for functional status. This resulted in a significant difference between pre and post treatment with a p-value of (0.001). In the experimental group, the mean score decreased from 19.2 to 11.1, also using the FSS for functional status. This too resulted in a significant difference between pre and post treatment with a p-value of (0.000).

Table 4.2: Statistical relationship of post treatment between control and experimental groups:

	Mean	SD	P. Value	Significance
Pain control.	.40	1.5	.320	Non sig
Hand grip.	1.68	14.6	.663	Non sig
Symptoms Severity.	.06	6.6	.970	Non sig
Functional Status.	.4	6.3	.810	Non sig

As indicated in table 4.2, there was no significant relationship identified between the control and experimental groups concerning pain management, hand grip strength, symptom severity, and functional status.

4. DISCUSSION

A total of 30 participants took part in the study. The participants were divided into two groups, with each group consisting of 15 individuals. The average age for both groups is 53 years. The research conducted by Hashimoto *et al.*, (2020), in Japan revealed that carpal tunnel syndrome (CTS) affects individuals over the age of 50. Additionally, this study identified a positive correlation between CTS and female gender. In this research, the number of female participants was greater in both groups, as indicated in the previous chapter. The average weight in both groups was 73 kg. This finding is consistent with the study by Elamian *et al.*, (2024), which reported an average weight of 83 kg with a variation of ± 11.71 . A notable enhancement in pain reduction was observed in both pre and post treatments for the two groups involved in this study. This finding aligns with the research conducted by Bittencourt *et al.*, (2024), which demonstrated a clear effect of neural mobilization on pain alleviation in patients with Carpal Tunnel Syndrome (CTS). It positively influences both sensory conduction velocity and motor conduction velocity. Consequently, it is recommended that neural mobilization be incorporated into the management strategies of physical therapy. Concerning hand grip, a notable enhancement was observed in both pre and post treatments for the two groups. This aligns with the previously mentioned effects on motor conduction velocity (Bittencourt et al, 2024; Syed *et al.*, 2023). The carpal bone mobilization technique proved effective in enhancing grip strength while treating participants with chronic CTS. Furthermore, the tendon gliding exercises served as a valuable adjunct that enhanced the effects of both the neurodynamic technique and the carpal bone mobilization technique. Concerning the severity of symptoms, a notable enhancement was observed in both pre- and post-treatment evaluations for

the two groups. The research conducted by Syed *et al.*, (2023), concluded that neural mobilization therapy was effective in alleviating the symptom severity of Carpal Tunnel Syndrome (CTS) (Syed *et al.*, 2023). This finding aligns closely with our discussion on the improvement of hand grip strength. In other terms, the carpal bone mobilization technique proved effective in diminishing symptom severity while treating participants with chronic CTS, and the tendon gliding exercises served as a beneficial adjunct that enhanced the effects of both the neurodynamic technique and the carpal bone mobilization technique.

Concerning Functional status, notable enhancement was observed in both pre and post treatments for the two groups. The research conducted by Syed *et al.*, (2023), concluded that neural mobilization therapy was effective in reducing symptom severity and improving hand function for patients with CTS (Abdelnour *et al.*, 2025: Syed *et al.*, 2023). No substantial relationship was identified between the control and experimental groups concerning pain management, hand grip strength, symptom severity, and functional status. There is no evident explanation for this observation. Consequently, the significant outcomes observed before and after treatment indicated that neural mobilization had a notable effect on the treatment of patients with Carpal Tunnel Syndrome (CTS).

5. CONCLUSION

The research indicated that neural mobilization had a significant impact on the treatment of patients with Carpal Tunnel Syndrome (CTS). This beneficial effect was evident in terms of pain reduction, severity of symptoms, and improvement in functional status. However, further studies are required to ascertain the effectiveness of neural mobilization for CTS patients.

Dedication: This article is dedicated to the memory of the first author's father, Mr. Napelion Nazeer Gilada (1949-2025), and his family.

REFERENCES

- [1] Abdelnour, H., Napelion, M., Alkazaleh, H., & Bleedy, N. (2025). Neural Mobilization and Carpal Tunnel Syndrome in Sudan. *International Journal of Environmental Sciences*, 11(23s). Online at: <https://doi.org/10.64252/fkwd6r59>
- [2] Abdelnour, H., Abdellatif, I., Ismail, P., & Jondi, T. (2023). Facts Related to the Prevalence of Sports Injury at Ahfad University for Women in Sudan. *International Journal of Novel Research in Interdisciplinary Studies*, 10(6), 20-26. Online at: <https://www.noveltyjournals.com/upload/paper/Facts%20Related%20to%20the%20Prevalence-26122023-6.pdf>
- [3] Abdalmagid, T., Abdelnour, H., & Aladwan, R. (2023). Physiotherapy Students and Clinical Education in Sudan. *International Journal of Novel Research in Healthcare and Nursing*, 10(3), 197-201. Online at: <https://www.noveltyjournals.com/upload/paper/Physiotherapy%20Students%20and%20Clinical-27102023-1.pdf>
- [4] Adam, M., Mohmmnden, D., Abdelnour, H., & Abdalmaged, T. (2025). Knowledge and Attitude of Physiotherapists Towards Communication Skills in Physical Therapy Sessions in Khartoum State of Sudan: A Cross-Sectional Study. *The Healer Journal of Physiotherapy and Rehabilitation Sciences*, 5(3), 47-54. Online at: <https://doi.org/10.55735/qpf9c04>
- [5] Alkazaleh, H., Adam, Y., Abdelnour, H., & Bleedy, N. (2024). Capsular stretching as physiotherapy technique for Sudanese patients with knee osteoarthritis in Al-Neelain University Physiotherapy Outpatient Clinic. *Fizjoterapia Polska*, 24(5). Online at: [Capsular stretching as physiotherapy technique.pdf](https://www.fizjoterapia.polska.pl/attachment/download/10105fd7-dddc-49a8-afe8-580932661af8)
- [6] Almalty, A. R., Mashaal, A. H., Hawamdeh, M., Bleedy, N., Abdelnour, H. M., & Mahmood, S. (2025). Efficacy of massage and stretching for controlling hamstring muscle spasticity in children with diplegic spastic cerebral palsy: A comparative study. *SPORT TK-Revista EuroAmericana de Ciencias del Deporte*, 14, 15-15. Online at: <https://digitum.um.es/entities/publication/10105fd7-dddc-49a8-afe8-580932661af8>
- [7] Almalty, A., Abdelnour, H., Bleedy, N., Ali, A., Salaheldien, A. (2024). Physiotherapists' Perceptions of Professional Ethics and Law. *Afr. J. Biomed. Res*, 27(4s): 7903 – 7909. Online at: [Physiotherapists' Perceptions of Professional Ethics and Law.pdf](https://www.afrjbr.com/attachment/download/10105fd7-dddc-49a8-afe8-580932661af8)
- [8] Bittencourt, J. V., Corrêa, L. A., Pagnez, M. A. M., do Rio, J. P. M., Telles, G. F., Mathieson, S., & Nogueira, L. A. C. (2024). Neural mobilisation effects in nerve function and nerve structure of patients with peripheral neuropathic

- pain: A systematic review with meta-analysis. *Plos one*, 19(11), e0313025. Online at: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0313025>
- [9] Eslamian, F., Novinbahador, T., Janati, M. J., Babaei, S., Dolati, S., & Dolatkah, N. (2024). Association Between Clinical Severity of Carpal Tunnel Syndrome and Physical Characteristics, Including Body Mass Index, Total and Segmental Body Composition. *Biomedical Research Bulletin*, 2(4):178-184. Online at: <file:///C:/Users/phark/Downloads/brb-8057.pdf>
- [10] Hashimoto, S., Ikegami, S., Nishimura, H., Uchiyama, S., Takahashi, J., & Kato, H. (2020). Prevalence and risk factors of carpal tunnel syndrome in Japanese aged 50 to 89 years. *The Journal of Hand Surgery (Asian-Pacific Volume)*, 25(03), 320-327. Online at: <https://www.worldscientific.com/doi/epdf/10.1142/S2424835520500356>
- [11] Leo, J. (2023). The Upper Limb: Historical Snippet: Alexander Augusta, The First African American Anatomy Professor in the US. In *Clinical Anatomy and Embryology: A Guide for the Classroom, Boards, and Clinic* (pp. 241-292). Cham: Springer International Publishing.
- [12] Osman, R., Abdelnour, H., & Elaalem, A. (2024). Physiotherapy use of Paraffin Wax for Rheumatoid Arthritis in Sudan. *International Journal of All Research Education and Scientific Methods*, 12(8). Online at: https://www.ijaresm.com/uploaded_files/document_file/Rawia_OsmanNaZJ.pdf
- [13] Sanjari, E., Raeisi Shahraki, H., G. Khachatryan, L., & Mohammadian-Hafshejani, A. (2024). Investigating the association between diabetes and carpal tunnel syndrome: A systematic review and meta-analysis approach. *Plos one*, 19(4), e0299442.
- [14] Sierra-Silvestre, E., Tachrount, M., Themistocleous, A. C., Stewart, M., Baskozos, G., & Schmid, A. B. (2024). Mechanisms of neurodynamic treatments (MONET): a protocol for a mechanistic, randomised, single-blind controlled trial in patients with carpal tunnel syndrome. *BMC Musculoskeletal Disorders*, 25, 590. Online at: <https://link.springer.com/content/pdf/10.1186/s12891-024-07713-6.pdf>
- [15] Syed, H., Ahmed, S. I., Arif, A., Zia, M., Shahbaz, N. N., & Kashif, M. (2023). Effects of soft tissue massage along with mobilization technique on intensity of symptoms and functional status of Carpal Tunnel Syndrome: A randomized controlled trial: Effects of soft tissue massage. *Pakistan Journal of Health Sciences*, 125-131. Online at: <https://thejas.com.pk/index.php/pjhs/article/view/1144/709>
- [16] Urits, I., Gress, K., Charipova, K., Orhurhu, V., Kaye, A. D., & Viswanath, O. (2019). Recent advances in the understanding and management of carpal tunnel syndrome: a comprehensive review. *Current pain and headache reports*, 23, 1-8.

Authors profile:

1. Marina Napelion.



MSc Physiotherapy, Senior Lecturer, Faculty of Physiotherapy, Ibn Sina University (ISU), Khartoum, Sudan. Email: marinanapelion@gmail.com. ORCID ID: <https://orcid.org/0009-0007-2809-2057>

2. Dr. Ahmed Banaga.



PhD Physiotherapy, Associate Professor, Faculty of Physiotherapy, Alnilin University (NU), Khartoum, Sudan. Email: Bannamed@gmail.com

3. Dr. Hassan Abdelnour.



PhD Physiotherapy. Assistant Professor, Faculty of Applied Medical Sciences, Physiotherapy Department, Jerash University (JU), Jerash, Jordan. School of Health Sciences, Physiotherapy Department, Ahfad University for Women (AUW), Omdurman, Sudan. Email: hasphysio@gmail.com. ORCID ID: <https://orcid.org/0009-0001-9873-5966>