Jurnal Keterapian Fisik
Vol. 11, No. 2, November 2026
https://doi.org/10.37341/jkf.v11i2.517

Original Research

Circumduction Shoulder Exercise Outperforms Stretching for Tension-Type Headache in Office Workers: A Quasi-Experimental Study

Safrin Arifin[1*], Salsabila Bil Wafa[1]

[1] Department of Physiotherapy, Vocational Education Program, Universitas Indonesia, Depok, Indonesia 16424.

ABSTRACT

Background: *Office workers face a high risk of Tension-Type Headache (TTH) due to static work postures that trigger neck and shoulder muscle tension. Circumduction shoulder exercise is a physiotherapy intervention that can improve local circulation and promote muscle relaxation.*

Methods: *A quasi-experimental study with a pretest–posttest control group design was conducted among 26 office workers diagnosed with TTH at the Dinas Transmigrasi dan Ketenagakerjaan of West Sumatra Province, Indonesia. Participants were allocated to an intervention group (n = 13) that received circumduction shoulder exercises (15 /week, 4 weeks, 1 min/session) and a control group (n = 13) that received shoulder stretching. TTH severity was assessed using the Headache Screening Questionnaire–Dutch Version (HSQ-DV), and pericranial muscle sensitivity was measured using the Total Tenderness Score (TTS). The Wilcoxon signed-rank test was used for intra-group comparisons and the Mann–Whitney U test for inter-group comparisons.*

Results: *In the intervention group, significant reductions were observed in both HSQ-DV scores (p = 0.002) and TTS (p = 0.001). In the control group, TTS improved significantly (p = 0.005), whereas HSQ-DV scores did not change significantly (p = 0.157). Inter-group comparison confirmed significantly greater reductions in the intervention group for both HSQ-DV (p = 0.002) and TTS (p = 0.019).*

Conclusion: *Circumduction shoulder exercise effectively reduced TTH symptoms and pericranial muscle tenderness in office workers, demonstrating superior outcomes compared to shoulder stretching alone. This exercise may serve as a practical, self-administered micro-break intervention for the prevention and management of TTH in workplace settings.*

ARTICLE HISTORY
Received: July 01st, 2026
Accepted: November 10th, 2026

KEYWORDS
circumduction shoulder, office workers, tension-type headache, total tenderness score;

CONTACT
Safrin Arifin
safrinarifin@ui.ac.id
Department of Physiotherapy, Vocational Education Program, Universitas Indonesia. Jl. Lingkar, Pondok Cina, Beji District, Depok City, West Java, Indonesia 16424.

This article is an open access article licensed under Creative Commons Attribution 4.0 International License (CC BY 4.0)

Cite this as: Circumduction Shoulder Exercise Outperforms Stretching for Tension-Type Headache in Office Workers: A Quasi-Experimental Study. (2026). *Jurnal Keterapian Fisik, 11*(2), 159-169. https://jurnalketerapianfisik.com/index.php/jpt/article/view/517

INTRODUCTION

Tension-Type Headache (TTH) is the most prevalent primary headache disorder worldwide, affecting approximately 26% of the adult population, with slightly higher

prevalence among women (27.1%) than among men (23.4%)(Stovner et al., 2022). TTH is characterised by bilateral, non-pulsating head pain of mild to moderate intensity, frequently accompanied by pericranial muscle tenderness, without associated nausea, vomiting, or significant photophobia (Headache Classification Committee of the International Headache Society [IHS], 2018). The condition imposes a substantial burden on individuals of working age, with peak prevalence reported among those aged 30–39 years (Global Burden of Disease [GBD], 2019), and is recognised as a leading cause of productivity loss and reduced quality of life in occupational settings.

Office workers represent a population at heightened risk for TTH due to prolonged static postures, sustained screen exposure, and limited physical activity during working hours (Calik et al., 2022); Jiriwibhakorn *et al*., 2022). Sustained cervical and shoulder muscle tension arising from non-ergonomic workstation postures activates myofascial trigger points (TrPs) in the pericranial and cervical muscles, which are consistently associated with the pathogenesis of TTH (Palacios-Ceña et al., 2018)(Cigarán-Méndez *et al*., 2019). In chronic TTH, these peripheral mechanisms converge with central sensitisation, further amplifying pain perception and tenderness (Jiang et al., 2019).

Physiotherapy-based interventions particularly exercise targeting the neck and shoulder musculature have demonstrated clinically meaningful reductions in TTH frequency and intensity. Andersen *et al*., (2017) reported that one hour per week of neck-shoulder resistance training reduced headache frequency and intensity by approximately 50% in office workers. Systematic reviews and meta-analyses have further confirmed that structured physical exercise is effective for both episodic and chronic TTH (Río et al., 2025)(Palacio-Del Río *et al*., 2025; Repiso-Guardeño *et al*., 2023). However, most studied interventions require dedicated time away from the workstation, limiting their practical implementation in occupational contexts.

Circumduction shoulder exercise is a compound movement involving the sequential combination of glenohumeral flexion, abduction, extension, and adduction in a continuous circular pattern (Muccioli *et al*., 2019). This exercise engages key shoulder and scapular muscles, including the deltoid, rotator cuff complex, trapezius, serratus anterior, and levator scapulae, and has been proposed to improve local circulation and reduce myofascial tension through repetitive muscle pump mechanisms (Ohmori *et al*., 2007; Niazi *et al*., 2025). As a micro-break exercise performable directly at the workstation without requiring equipment or therapist supervision, the circumduction shoulder exercise may represent a highly accessible and scalable intervention for TTH in occupational settings.

To date, no published study has specifically evaluated the effect of circumduction shoulder exercise on TTH and pericranial muscle tenderness using validated outcome measures in an office worker population. The present study aimed to determine the effect of a four-week circumduction shoulder exercise program on TTH symptoms, as assessed by the Headache Screening Questionnaire-Dutch Version (HSQ-DV), and on pericranial muscle sensitivity, as assessed by the Total Tenderness Score (TTS), compared to a shoulder stretching control intervention.

MATERIALS AND METHOD

Research Design

This study employed a quasi-experimental design with a non-equivalent pretest-posttest control-group design. The study was conducted at the Dinas Transmigrasi dan

Ketenagakerjaan (Department of Transmigration and Labor) of West Sumatra Province, located in Padang, Indonesia, between January and February 2026. Ethical approval was obtained from the Research Ethics Committee of the Vocational Education Program, Universitas Indonesia (Protocol No. KES-32/01/2026), and all participants provided written informed consent prior to enrollment.

Population and Participants

The target population comprised all 54 office workers employed at the study site. Purposive sampling was used to identify eligible participants according to predefined inclusion and exclusion criteria. Inclusion criteria were: (1) office worker aged 25-64 years; (2) bilateral head pain; (3) neck and shoulder muscle tension complaints; and (4) pericranial trigger points with tenderness confirmed on palpation. Exclusion criteria were: (1) history of cervical fracture or trauma; (2) cervical radiculopathy confirmed by a positive Spurling's test; (3) history of cervical nerve injury; (4) current use of analgesic medication; and (5) unwillingness or inability to complete the full intervention period.

The independent variable was circumduction shoulder exercise, performed se times per week over four weeks, while the dependent variables were tension-type headache symptoms and pericranial muscle tenderness. Headache symptoms were assessed using the Headache Screening Questionnaire–Dutch Version (HSQ-DV), while pericranial muscle tenderness was assessed using the Total Tenderness Score (TTS). Participants were allocated to the intervention group (n = 13) or the control group (n = 13) using non-random assignment based on workstation location to minimize contamination. The control group received shoulder stretching.

Outcome Measures

The primary outcome, TTH symptoms, was assessed using the Headache Screening Questionnaire–Dutch Version (HSQ-DV), a 10-item self-report questionnaire developed by van der Meer et al., to screen for migraine and tension-type headache. The Indonesian version was used in this study. Previous research by Mahendra and Murlina, (2021) reported a Cronbach’s alpha of 0.718 and statistically significant Pearson correlation results ($p < 0.05$). In the present sample, Cronbach’s alpha was 0.65, while item-total correlation coefficients ranged from 0.456 to 0.682, exceeding the reported critical value of 0.444.

The secondary outcome, pericranial muscle tenderness, was assessed using the Total Tenderness Score (TTS), a validated physical examination tool developed by Langemark and Olesen. Bilateral palpation was performed on eight paired muscle and tendon insertion sites: masseter, temporalis, frontalis, trapezius, sternocleidomastoid, suboccipital muscles, and the coronoid and mastoid processes. Tenderness at each site was scored on a four-point scale (0–3), and scores from both sides were summed to yield a TTS maximum of 48. A TTS of ≥ 8 is used to classify pericranial TTH according to IHS guidelines. TTS has demonstrated high sensitivity (97.1%) for identifying TTH (Cigarán-Méndez *et al*., 2025).

Intervention Protocol

The intervention consisted of shoulder circumduction exercises performed for 1 minute per session, three times per day, five days per week, over four weeks. The prescribed schedule comprised 15 sessions per week and 60 sessions over the four-week

intervention period. The total planned exercise time was 60 minutes, assuming full adherence to all sessions. The exercise was performed in a seated upright position: both hands were placed on the ipsilateral shoulders with fingers touching the shoulder apex, and the elbows traced a continuous circular path (upward, forward, downward, and backward) in a smooth, rhythmic motion with elbows flexed to reduce rotational load on the glenohumeral joint. Sessions were conducted under the researcher's supervision at the workplace, with a reminder and monitoring log provided to promote adherence. The control group performed passive shoulder stretching exercises of equivalent duration and frequency, supervised by the same researcher. Both groups received no pharmacological treatment or other physiotherapy interventions during the study period.

Data Collection

Baseline (pretest) data were collected on January 19, 2026, prior to the first intervention session. Post-intervention (posttest) data were collected between February 20-23, 2026, immediately after completion of the four-week program. The HSQ-DV was administered as a self-completed questionnaire; a subset was completed remotely via WhatsApp messaging when in-person completion was not feasible. TTS assessment was performed by the researcher through manual palpation at both time points.

Statistical Analysis

Descriptive statistics (mean ± standard deviation, median, minimum, maximum) were computed for all continuous variables. Normality of data distribution was assessed using the Shapiro–Wilk test, which indicated that none of the outcome variables were normally distributed (all $p < 0.05$). Accordingly, nonparametric statistical tests were employed: the Wilcoxon signed-rank test for within-group pre-and post-comparisons and the Mann-Whitney U test for between-group comparisons. Statistical significance was defined as $p < 0.05$. All analyses were conducted using IBM SPSS Statistics version 27.

Participants and Group Allocation

The study population consisted of 54 individuals. Of these, 26 met the eligibility criteria and were included in the study, with 13 participants assigned to the intervention group and 13 to the control group. Group allocation was based on workstation location: participants working in the main building were assigned to the intervention group, whereas those working in the branch building were assigned to the control group. This allocation was intended to reduce potential contamination between groups. However, because allocation was not randomized, differences between the groups and potential selection bias cannot be ruled out.

RESULTS

Of the 54 office workers screened, 26 met the eligibility criteria and completed all study procedures; no participant withdrew during the intervention period. The intervention group comprised 3 males (23.1%) and 10 females (76.9%); the control group comprised 2 males (15.4%) and 11 females (84.6%). Both groups were predominantly middle-aged, with the intervention group dominated by participants aged 25-35 years (38.5%) and the control group by those aged 36-45 years (38.5%). The most common working duration in both groups was 4-6 hours per day (Table 1).

Table 1. Demographic Characteristics of Study Participants

Characteristic	Intervention (n = 13)	Control (n = 13)
Gender		
Male	3 (23.1%)	2 (15.4%)
Female	10 (76.9%)	11 (84.6%)
Age group (years)		
25–35	5 (38.5%)	4 (30.8%)
36–45	3 (23.1%)	5 (38.5%)
46–55	3 (23.1%)	3 (23.1%)
> 55	2 (15.4%)	1 (7.7%)
Daily working duration		
< 4 hours	2 (15.4%)	4 (30.8%)
4–6 hours	6 (46.2%)	4 (30.8%)
6–8 hours	4 (30.8%)	3 (23.1%)
> 8 hours	1 (7.7%)	2 (15.4%)

Source: Primary Data, 2026

In the intervention group, HSQ-DV scores decreased from a baseline mean of 5.69 (SD = 1.11) to 3.85 (SD = 0.99). In the control group, scores decreased from 5.23 (SD = 1.30) to 4.92 (SD = 1.32). For TTS, the intervention group showed a decrease from 11.08 (SD = 5.95) to 3.92 (SD = 3.99), while the control group decreased from 7.77 (SD = 3.77) to 4.31 (SD = 3.47). Within-group analyses indicated statistically significant changes in both outcomes in the intervention group. The control group showed a statistically significant change in TTS, but not in HSQ-DV. Between-group comparisons also indicated statistically significant differences in changes in HSQ-DV and TTS.

Table 2. Descriptive Statistics for HSQ-DV and TTS Scores at Pretest and Posttest

Variable	Pretest Mean ± SD	Posttest Mean ± SD	Δ Mean
HSQ-DV Score			
Intervention group	5.69 ± 1.11	3.85 ± 0.99	−1.84
Control group	5.23 ± 1.30	4.92 ± 1.32	−0.31
TTS Score			
Intervention group	11.08 ± 5.95	3.92 ± 3.99	−7.16
Control group	7.77 ± 3.77	4.31 ± 3.47	−3.46

Source: Primary Data, 2026

Results of the Wilcoxon signed-rank test and Mann-Whitney U test are presented in Table 3. Within the intervention group, statistically significant reductions were observed for both HSQ-DV scores ($Z = -3.051$, $p = 0.002$) and TTS ($Z = -3.186$, $p = 0.001$). Within the control group, TTS decreased significantly ($Z = -2.803$, $p = 0.005$), whereas HSQ-DV scores did not change significantly ($Z = -1.414$, $p = 0.157$). Inter-

group comparison by Mann–Whitney U test demonstrated that the intervention group achieved significantly greater reductions than the control group in HSQ-DV scores (U = 31.5, p = 0.002) and TTS (U = 39.0, p = 0.019).

Table 3. Wilcoxon Signed-Rank Test and Mann–Whitney U Test Results

Outcome / Comparison	Z	p-value	Interpretation
Wilcoxon Signed-Rank Test (Within-group)			
HSQ-DV – Intervention group	−3.051	0.002*	Significant
HSQ-DV – Control group	−1.414	0.157	Not significant
TTS – Intervention group	−3.186	0.001*	Significant
TTS – Control group	−2.803	0.005*	Significant
Mann–Whitney U Test (Between-group)			
HSQ-DV (Intervention vs. Control)	−3.099	0.002*	Significant
TTS (Intervention vs. Control)	−2.348	0.019*	Significant

Source: Primary Data, 2026

DISCUSSION

The present study is among the first to systematically evaluate the shoulder circumduction exercise as a targeted intervention for TTH in office workers, using validated physiotherapy outcome measures. The principal findings demonstrate that a 4-week program of circumduction shoulder exercises significantly reduced both TTH symptom severity, as measured by the HSQ-DV, and pericranial muscle tenderness, as measured by TTS, with outcomes superior to those with shoulder stretching alone. The significant reduction in TTS observed in the intervention group (from 11.08 ± 5.95 to 3.92 ± 3.99; p = 0.001) reflects meaningful alleviation of pericranial muscle sensitivity. Elevated TTS is a hallmark finding in TTH, arising from activation of myofascial TrPs in the pericranial and cervical musculature, which sensitize peripheral nociceptors and, over time, contribute to central sensitization (Jiang *et al*., 2019; Fernández-de-las-Peñas *et al*., 2010).

The muscle pump mechanism, intrinsic to shoulder circumduction exercises, facilitates rhythmic contraction and relaxation of the shoulder girdle muscles, thereby improving local microcirculation. This increased perfusion helps normalise the biochemical environment of ischemic muscle tissue by accelerating the clearance of pro-nociceptive metabolites, such as Substance P and other inflammatory byproducts, that accumulate during static postures. In contrast to the accumulation of nitric oxide (NO), which is often associated with triggering pain in the acute phase, this dynamic exercise-induced blood flow supports healthy endothelial function, thereby helping to break the pain-spasm-ischemia cycle in pericranial muscles (Ohmori *et al*., 2007; Niazi *et al*., 2025).

These biochemical changes are consistent with the observed reduction in pericranial tenderness and are analogous to mechanisms described in other dynamic upper-extremity exercise studies (Rinne *et al*., 2023). The significant improvement in HSQ-DV scores in the intervention group (from 5.69 ± 1.11 to 3.85 ± 0.99; p = 0.002), but not in the control group (p = 0.157), highlights a mechanistic distinction between circumduction shoulder exercise and static stretching. Passive stretching primarily modulates mechanoreceptor activity and induces parasympathetic-mediated relaxation

at the tissue level, producing limited and transient effects on headache symptomatology (Reyes *et al*., 2025; Warneke *et al*., 2023).

In contrast, the dynamic neuromuscular engagement of circumduction exercises stimulates mechanoreceptors in periarticular tissues, which is hypothesised to activate descending pain-inhibitory pathways. Although the intervention is short-lived, as a micro-break, this repetitive stimulation likely contributes to systemic neurotransmitter modulation, including potentially increasing the availability of serotonin and endogenous opioids, which are typically decreased in patients with TTH. This neuromodulatory effect explains why shoulder circumduction exercises produce greater improvements in HSQ-DV scores than passive stretching, which acts only at the level of local tissue extensibility (Pellesi *et al*., 2025). This systemic neuromodulatory effect may explain why circumduction shoulder exercise, but not stretching alone, produced significant improvements in HSQ-DV scores.

These findings align with and extend the existing evidence base. Andersen *et al*. (2017) demonstrated that one hour per week of neck-shoulder resistance training reduced TTH frequency and intensity by approximately 50% in office workers. Rinne *et al*. (2023) found that a six-month progressive neck-shoulder exercise program halved weekly headache frequency in women with chronic headache. Our study differs importantly in that circumduction shoulder exercise was delivered as a brief, self-administered micro-break (1 minute per session) without specialized equipment, demonstrating its feasibility and effectiveness within the occupational environment. This practical advantage addresses a recognized barrier to workplace exercise-based TTH management (Repiso-Guardeño *et al*., 2023).

The significant reduction in TTS in the control group ($p = 0.005$), despite no significant improvement in HSQ-DV, warrants consideration. Shoulder stretching promotes myofascial flexibility and tissue extensibility through sustained mechanoreceptor activation and sympatholytic effects, which may reduce local muscle tenderness (Warneke *et al*., 2023). However, static stretching appears insufficient to modulate the central and systemic pain-processing mechanisms that underlie headache symptomatology in TTH, consistent with the literature differentiating local tissue effects of passive stretching from the broader neuromuscular effects of dynamic exercise (Gunn *et al*., 2019). The control group TTS improvement may also reflect a partial non-specific response to therapeutic attention and consistent physical activity.

The demographic profile of participants predominantly female, working-age adults is consistent with the established epidemiology of TTH, in which women exhibit higher prevalence, more active TrPs, and lower pressure pain thresholds than men (Xu *et al*., 2025; Cigarán-Méndez *et al*., 2019). The positive relationship observed between working duration and TTS scores corroborates evidence linking prolonged static postures to ischemia-induced lactic acid accumulation and the release of pro-nociceptive metabolites in the neck and shoulder musculature (Kurniawan *et al*., 2022). Several limitations should be acknowledged.

The relatively small sample size and single-site design limit the generalizability of findings. Potential confounding variables, including psychological stress, sleep quality, ergonomic conditions, and adherence to home-based exercise between sessions, were not controlled or measured. The short intervention duration precludes conclusions about long-term treatment effects. Self-report outcomes may be susceptible to response bias. Future studies should employ larger, multicenter randomized controlled trial designs with blinded assessors, longer follow-up periods, and objective outcome measures such

as pressure algometry for TTS quantification and actigraphy for physical activity monitoring.

Several limitations should be considered when interpreting these findings. First, the relatively small sample size of 26 participants may limit the generalizability of the results. Second, the non-random allocation of participants according to workstation location may have introduced selection bias and baseline differences between groups. Third, the study was conducted in a single workplace setting, which may limit applicability to other populations. Finally, the lack of documented assessor blinding may have introduced measurement bias, particularly in the assessment of tenderness. Future studies involving larger samples, randomized allocation, and blinded outcome assessment are warranted.

CONCLUSION

A four-week circumduction shoulder exercise program, administered as a brief daily micro-break intervention, significantly reduced TTH symptom severity and pericranial muscle tenderness in office workers, demonstrating superior efficacy compared to passive shoulder stretching. The exercise appeared to exert both peripheral (muscle pump, metabolite clearance) and central (endogenous pain modulation) mechanisms of action not achieved by stretching alone. Circumduction shoulder exercise is a practical, equipment-free, self-administered intervention that can be easily integrated into occupational settings, making it a promising strategy for the physiotherapy-led prevention and management of TTH in office worker populations. Healthcare professionals, particularly physiotherapists, are encouraged to consider incorporating this exercise into workplace health promotion programs. Randomized controlled trials with larger samples and longer follow-up are warranted to confirm these findings and establish optimal dosing parameters.

ACKNOWLEDGEMENT

The authors express sincere gratitude to the management and staff of the Dinas Transmigrasi dan Ketenagakerjaan of West Sumatra Province for facilitating the study and granting access to participants. The authors also thank the Research Ethics Committee of the Vocational Education Program at Universitas Indonesia for ethical approval and the study participants for their voluntary participation.

REFERENCES

Andersen, C. H., Jensen, R., Dalager, T., Zebis, M. K., Sjøgaard, G., & Andersen, L. L. (2017). Effect of resistance training on headache symptoms in adults: Secondary analysis of a randomized controlled trial. *Musculoskeletal Science and Practice*, 32, 38–43. https://doi.org/10.1016/j.msksp.2017.08.008.

Çalik, B. B., Yagci, N., Oztop, M., & Caglar, D. (2020). Effects of risk factors related to computer use on musculoskeletal pain in office workers. *International Journal of Occupational Safety and Ergonomics*, 28(1), 269–274. https://doi.org/10.1080/10803548.2020.1770388.

Cigarán-Méndez, M., Jiménez-Antona, C., Parás-Bravo, P., Fuensalida-Novo, S., Rodríguez-Jiménez, J., & Fernández-de-las-Peñas, C. (2019). Active trigger points are associated with anxiety and widespread pressure pain sensitivity in

women, but not men, with tension-type headache. *Pain Practice*, 19(5), 522–529. https://doi.org/10.1111/papr.12775.

Cigarán-Méndez, M., Pacho-Hernández, J. C., Tejera-Alonso, A., Valera-Calero, J. A., Fernández-Palacios, F. G., & Fernández-de-las-Peñas, C. (2025). Diagnostic accuracy of muscle tenderness, but not pressure pain thresholds, to discriminate children with tension-type headache. *Pediatric Neurology*, 169, 1–4. https://doi.org/10.1016/j.pediatrneurol.2025.01.009.

Fernández-de-las-Peñas, C., Arendt-Nielsen, L., & Gerwin, R. D. (Eds.). (2010). Tension-type and cervicogenic headache: Pathophysiology, diagnosis, and management. Jones and Bartlett Publishers.

Global Burden of Disease Study 2019 Collaborators. (2019). Global, regional, and national burden of migraine and tension-type headache, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet Neurology*, 21(12), 1040–1053.

Gunn, L. J., Scott, B. E., & Wilhite, K. L. (2019). Effectiveness of exercise and manual therapy versus exercise only on headache characteristics and cervical range of motion in tension-type headache patients. *Manual Therapy*, 44, 1–6.

Headache Classification Committee of the International Headache Society. (2018). The International Classification of Headache Disorders, 3rd edition. Cephalalgia, 38(1), 1–211. https://doi.org/10.1177/0333102417738202.

Jiang, W., Li, Z., Wei, N., Chang, W., Chen, W., & Sui, H. J. (2019). Effectiveness of physical therapy on the suboccipital area of patients with tension-type headache: A meta-analysis of randomized controlled trials. *Medicine*, 98(19), e15487. https://doi.org/10.1097/MD.0000000000015487.

Jiriwibhakorn, S. (2022). Prevention and treatment of office syndrome of Royal Thai Air Force personnel with holistic approach. Royal Thai Air Force Medical Gazette, 68(1), 40–48.

Kurniawan, B., Rahfiludin, Z., Setyaningsih, Y., & Nurjazuli. (2022). Ergonomic risk, muscle tension, lactic acid, and work performance on transport workers at fish auction. *Media Kesehatan Masyarakat Indonesia*, 18(2), 50–56. https://doi.org/10.30597/mkmi.v18i2.19739.

Mahendra, A. K., & Murlina, N. (2021). Hubungan kecemasan dengan kejadian tension-type headache pada mahasiswa kedokteran Universitas Muhammadiyah Sumatera Utara tahun 2020. *Jurnal Ilmiah Maksitek*, 6(4), 11–16.

Muccioli, G., Borroni, G., Brambilla, A., Zerbi, S., & Mosconi, M. (2019). Clinical anatomy and biomechanics of the sporting shoulder. *In Sports injuries of the shoulder. Springer*. https://doi.org/10.1007/978-3-030-23029-6_1.

Niazi, S., Gandomi, F., Soufivand, P., & Ghazaleh, L. (2025). The effect of tissue stretching and release strategies on neck muscles fatigue and pain intensity in office workers affected by chronic neck pain: A rater-blind, semi-experimental study. *Health Science Reports*, 8(4), e70748. https://doi.org/10.1002/hsr2.70748.

Ohmori, F., Shimizu, S., & Kagaya, A. (2007). Exercise-induced blood flow in relation to muscle relaxation period. *Dynamic Medicine*, 6(1), 5. https://doi.org/10.1186/1476-5918-6-5.

Palacios-Ceña, M., Wang, K., Castaldo, M., Guillem-Mesado, A., Ordás-Bandera, C., Arendt-Nielsen, L., & Fernández-de-las-Peñas, C. (2018). Trigger points are associated with widespread pressure pain sensitivity in people with tension-type headache. *Cephalalgia*, 38(2), 237–245. https://doi.org/10.1177/0333102417694173.

Palacio-Del Río, C., Monti-Ballano, S., Lucha-López, M. O., Hidalgo-García, C., & Tricás-Moreno, J. M. (2025). Effect of exercise on chronic tension-type headache and chronic migraine: A systematic review. Healthcare, 13(3), 256. https://doi.org/10.3390/healthcare13030256.

Pellesi, L., Yangjeh, A., Hajjaj, I., Lababidi, M., Sarwar, F., Wang, W., & Martelletti, P. (2025). Neurotransmitter imbalance in tension-type headache: A systematic review of mechanisms and therapeutic targets. *Pain and Therapy*, 14(4), 1279–1291. https://doi.org/10.1007/s40122-025-00761-3.

Repiso-Guardeño, A., Moreno-Morales, N., Armenta-Pendón, M. A., Rodríguez-Martínez, M. C., Pino-Lozano, R., & Armenta-Peinado, J. A. (2023). Physical therapy in tension-type headache: A systematic review of randomized controlled trials. *International Journal of Environmental Research and Public Health*, 20(5), 4466. https://doi.org/10.3390/ijerph20054466.

Reyes, J. L., Keller, C., Kosmopoulos, M., & Benditt, D. G. (2025). Stretch-induced blood pressure moderation: A potential basis for the sense of well-being accompanying stretching of upper back and neck muscles. *Physiological Reports*, 13(18), e70569. https://doi.org/10.14814/phy2.70569.

Rinne, M., Garam, S., Kukkonen-Harjula, K., Tokola, K., Häkkinen, A., Ylinen, J., & Nikander, R. (2023). Neck-shoulder region training for chronic headache in women: A randomized controlled trial. *Clinical Rehabilitation*, 37(10), 1347–1357. https://doi.org/10.1177/02692155231173049.

Stovner, L. J., Hagen, K., Linde, M., & Steiner, T. J. (2022). The global prevalence of headache: An update, with analysis of the influences of methodological factors on prevalence estimates. *The Journal of Headache and Pain*, 23(1), 34. https://doi.org/10.1186/s10194-022-01402-2.

Warneke, K., Hillebrecht, M., Claassen-Helmers, E., Wohlann, T., Keiner, M., & Behm, D. G. (2023). Effects of a home-based stretching program on bench press maximum strength and shoulder flexibility. *Journal of Sports Science and Medicine*, 22, 597–604. https://doi.org/10.52082/jssm.2023.597.

Xu, H., Qin, X., Zhao, G., Feng, Z., & You, S. (2025). Analysis and 15-year projections of the global burden of tension-type headache by sex from 1990 to 2021: A systematic review of GBD 2021 data. *Journal of Pain Research*, 18, 3505–3517. https://doi.org/10.2147/JPR.S512335.