# Differences in the effect of manual therapy combination in the exercise on the functional neck of workers with neck pain

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## Abstract

Working with an unergonomic posture can cause fatigue more quickly and increase the risk of musculoskeletal disorders, such as neck pain. Neck pain is a common complaint among workers, and it can reduce neck function and work productivity. This study aims to determine the differences in the effects of a combination of Deep Transverse Friction (DTF) with Workplace Exercise (WE) and a combination of Deep Transverse Friction (DTF) with Dynamic Strength-Endurance Training (DSET) on neck function in workers with neck pain. This study employed a randomized controlled trial design with 20 participants divided into two groups. The interventions were administered for four weeks and measured using the Neck Disability Index (NDI). Hypotheses I and II were tested using a paired sample t-test, while Hypothesis III was tested using an independent sample t-test. The analysis showed that both intervention combinations significantly improved neck function with a p-value of 0.000 ($p < 0.05$). However, there was no significant difference between the treatment groups with a p-value of 0.152 ($p > 0.05$). These findings indicate that both intervention methods are equally effective in treating neck pain, despite their different physiological approaches. This study recommends that both therapy combinations be considered in physiotherapy programs for workers with neck dysfunction.

**Keywords:** functional neck; neck pain; workers

## 1. Introduction

Neck pain is one of the most common musculoskeletal disorders among workers, particularly those exposed to prolonged static working postures. Maintaining a forward-bent or extended neck position of more than 20° for extended periods can lead to muscle tension, spasms, and chronic pain (Situmorang et al., 2020; To et al., 2020). Although often considered minor, this condition can significantly affect mobility and quality of life if not managed appropriately (Sari & Rifai, 2019).

According to data from the *Global Burden of Disease, Injuries, and Risk Factors Study* in 2019, neck pain ranks fifth among musculoskeletal disorders, with approximately 223 million people affected worldwide. The World Health Organization (WHO) reports that neck pain impacts around 34.4 million workers globally each year. In Indonesia, the prevalence of neck pain is recorded at 60% among office workers (Mujiono et al., 2023), while a study conducted in Yogyakarta found a prevalence of 68% in 2016 (Khusnaini et al., 2020).

Neck pain is a common complaint among workers, especially those engaged in prolonged static activities, causing not only discomfort but also reduced productivity and quality of life. Various therapeutic methods have been developed; however, studies combining *Deep Transverse Friction* (DTF) with *Workplace Exercise* (WE) and *Dynamic Strength-Endurance Training* (DSET) in the context of cervical function among workers with neck pain remain scarce. A preliminary study conducted at Klick Express Company found that 11 out of 26 employees experienced decreased cervical function due to neck pain. Therefore, it is necessary to examine whether there is a difference in the effects between the combination of DTF with WE and DTF with DSET on cervical function in workers with neck pain.

*Deep Transverse Friction* (DTF) has been proven effective in reducing pain and improving cervical range of motion, as it facilitates blood circulation, decreases pain, and releases tissue adhesions. The intervention involves applying friction massage to muscles with trigger points for three minutes, administered 6–10 times (I Putu Mahendra Putra et al., 2020; Choksi et al., 2021). *Workplace Exercise* (WE) uses a combination of stretching and strengthening techniques that can be performed without special equipment, aiming to enhance flexibility, relax muscles, strengthen muscles, and provide comfort. It has been shown to effectively reduce neck pain when performed for 20 minutes per session in two repetitions targeting the cervical area (Luik et al., 2021; Putri et al., 2023). *Dynamic Strength-Endurance Training* (DSET) is an exercise approach combining dynamic strength and muscular

endurance components, proven to enhance physical capacity, reduce injury risk, alleviate neck pain, and improve muscle function in individuals with nonspecific neck pain after four weeks of training (Petré et al., 2021; Priya et al., 2023).

Although previous research has demonstrated the effectiveness of each intervention separately, there remains a research gap concerning the comparative effectiveness of combining DTF with WE versus DTF with DSET on cervical function among workers with neck pain. This study is needed to provide *evidence-based practice* for selecting the most effective intervention to address cervical functional problems in the working population affected by neck pain.

The objective of this study is to determine the difference in effects between the combination of DTF with WE and the combination of DTF with DSET on cervical function in workers with neck pain. Additionally, the study aims to assess the effectiveness of each combination in improving cervical functional ability, thereby providing recommendations for the most optimal intervention to address neck pain among workers.

## 2. Method

The This study employed a randomized controlled trial design involving 20 workers aged 19–59 years who experienced neck pain at Klick Express Company. The sample size was determined using Slovin's formula and was randomly assigned into two groups: the first group received a combination of DTF and WE, while the second group received a combination of DTF and DSET.

The independent variables included DTF (3 minutes per day, twice per week), WE (20 minutes per day, three times per week), and DSET (20 minutes per day, three times per week) over a four-week period. The dependent variable was cervical function, measured using the Neck Disability Index (NDI). The instruments used consisted of an informed consent form, a validated NDI questionnaire, a stopwatch to monitor intervention duration, and an aneroid sphygmomanometer as a pressure biofeedback device.

The inclusion criteria were: workers who used a computer for more than six hours per day, aged 19–59 years, experiencing neck pain with an NDI score of 20–40%, and exhibiting cervical muscle spasms. Data were analyzed using SPSS version 26, employing descriptive analysis, the Shapiro–Wilk test for normality, Levene's test for homogeneity, and hypothesis testing using the Paired Sample t-test for pre–post comparisons and the Independent Sample t-test for between-group comparisons, with a significance level set at $p < 0.05$.

## 3. Results and Discussion

### 3.1. Respondent Characteristics

In this study, respondent characteristics were classified into five categories: age, gender, working hours per day, length of employment, and body mass index (BMI). The details are presented in Table 1.

**Table 1.** Respondent Distribution by Patient Characteristics

| | DTF& WE | | DTF& DSET | |
|---|---|---|---|---|
| | **Frekuensi** | **Presentase** | **Frekuensi** | **Presentase** |
| **Age** | | | | |
| 19-29 years | 8 | 80.0 | 8 | 80.0 |
| 30-39 years | 2 | 20.0 | 2 | 20.0 |
| 40-49 years | 0 | 0 | 0 | 0 |
| 50-59 years | 0 | 0 | 0 | 0 |
| **Gender** | | | | |
| Male | 2 | 20.0 | 5 | 50.0 |
| Female | 8 | 80.0 | 5 | 50.0 |
| **Working Hours/day** | | | | |
| <6 jam | 0 | 0 | 0 | 0 |
| >6 jam | 10 | 100.0 | 10 | 100.0 |
| **Length of Employment** | | | | |
| 2 years | 3 | 30.0 | 2 | 20.0 |

| | DTF& WE | | DTF& DSET | |
|---|---|---|---|---|
| | **Frekuensi** | **Presentase** | **Frekuensi** | **Presentase** |
| 3 years | 3 | 30.0 | 2 | 20.0 |
| 4 years | 1 | 10.0 | 2 | 20.0 |
| 5 years | 2 | 20.0 | 2 | 200 |
| 6 years | 0 | 0 | 1 | 10.0 |
| 7 years | 1 | 10.0 | 0 | 0 |
| 8 years | 0 | 0 | 0 | 0 |
| 9 years | 0 | 0 | 1 | 10.0 |
| **IMT** | | | | |
| Underweight | 2 | 20.0 | 1 | 10.0 |
| Normal weight | 6 | 60.0 | 7 | 70.0 |
| Overweight | 2 | 20.0 | 2 | 20.0 |
| Obesity | 0 | 0 | 0 | 0 |
| Extremely obesity | 0 | 0 | 0 | 0 |

Based on Table 1, the sex distribution shows that in the DTF & WE group, the majority were female (n = 8; 80%), whereas in the DTF & DSET group, there was an equal proportion of males and females (n = 5; 50% each). Neck pain is more frequently reported by women than men, which is closely related to physiological factors, as men generally possess greater muscle strength than women (Kazeminasab et al., 2022). A study by Koch et al., (2025) revealed that women are physiologically more susceptible to neck pain due to lower cervical muscle strength, even during light activities, as well as hormonal differences and heightened nervous system sensitivity, all of which contribute to an increased risk of muscle fatigue and static tension. Nevertheless, men are also at risk of developing musculoskeletal disorders due to heavier workloads, which may lead to muscle fatigue and trigger pain (Diani & Hafifah, 2019).

In terms of age, most respondents in both groups were aged 19–29 years (n = 8; 80%), with the remainder in the 30–39 year range. No respondents were aged 40 years or older. The age distribution of respondents, which was dominated by younger individuals, is consistent with the findings of Jahre et al., (2020), indicating that individuals aged 18–29 years are vulnerable to neck pain due to poor ergonomic factors, prolonged computer use, and psychological stress. Age is an important determinant influencing musculoskeletal disorders (MSDs), with symptom onset generally occurring between the ages of 20 and 40 years as a consequence of both static and dynamic physical activities, as well as the initial stages of minimal degenerative processes (Tarwaka, 2016). Although significant structural degeneration has not yet occurred, maintaining improper posture for extended periods can lead to muscle fatigue, microtrauma, and tissue tension, which may trigger complaints of neck pain.

Regarding working hours per day, all respondents in both groups reported working more than six hours per day (100%). Prolonged working hours in a sustained forward-bent position can induce continuous contraction of the cervical muscles, leading to fatigue, spasms, and pain. Non-ergonomic working postures and static load further exacerbate the condition, as workers with a daily working duration of 7–8 hours have limited rest periods, thereby increasing the risk of neck pain (Utami et al., 2017). This finding is consistent with Nurhidayanti et al., (2021), who demonstrated that workers with 8–9 working hours per day in non-ergonomic postures are more likely to develop neck pain complaints. Length of employment also contributes to the occurrence of neck pain, which may develop over extended employment periods of more than two years, particularly in jobs involving repetitive activities or prolonged static postures (Mekonnen). Jufri & Indriani, (2023) support this finding by reporting a significant correlation between length of employment and neck pain complaints. Epidemiological studies indicate that acute neck pain is reported more frequently than chronic neck pain among workers, which may be attributed to the phenomenon of pain normalization. Approximately 34% to 49% of workers report a new onset of neck pain during a one-year follow-up period (Qu et al., 2022).

With regard to Body Mass Index (BMI), although the majority of respondents had a normal BMI, neck pain complaints were still reported. This is consistent with Weerakoon et al., (2021), who reported that individuals with a normal BMI who work with computers for prolonged periods are at risk of developing neck pain. Panggabean & Pujiastuti, (2021) stated that there is no significant association

between BMI and the incidence of neck pain, indicating that neck pain complaints are not solely influenced by body weight status.

### 3.2. Effect of the Combination of DTF and WE on Cervical Function

The analysis of the effect of the combination of DTF and WE on cervical function among workers with neck pain is presented in Table 2 below.

**Table 2.** The Effect of DTF & WE Combination on Neck Function

| | Mean | n | Std. Deviation | Sig. |
|---|---|---|---|---|
| Pre Test DTF& WE | 29.00 | 10 | 6.200 | 0.000* |
| Post Test DTF& WE | 8.20 | 10 | 3.824 | |

*Note:* $p < 0.05$ indicates statistical significance.

Table 2 presents the results of the analysis on the effect of the combination of DTF and WE on cervical function among workers with neck pain using the paired sample t-test. The results show a *p*-value of 0.000 ($p < 0.05$), indicating a significant effect of the DTF and WE combination on improving cervical function in workers with neck pain. The combination of DTF and WE demonstrated significant effectiveness in addressing neck pain through complementary physiological mechanisms. Workplace Exercise (WE) provides long-term benefits through strengthening and stretching exercises (Dewi et al., 2018). The combined physiological effects include increased range of motion, reduced muscle stiffness, and improved musculoskeletal health (Izquierdo et al., 2021). This combination works optimally as DTF prepares the tissue by reducing pain and enhancing mobility, while WE reinforces these benefits through progressive strengthening and postural correction. The effectiveness of WE has been confirmed in a study by Putri et al., (2023), which reported a significant reduction in neck pain severity. Together, these modalities offer a comprehensive approach that addresses both the acute and chronic aspects of neck pain.

### 3.3. Effect of the Combination of DTF and DSET on Cervical Function

The analysis of the effect of the combination of DTF and DSET on cervical function among workers with neck pain is presented in Table 3 below:

**Table 3.** The Effect of DTF & DSET Combination on Neck Function

| | Mean | n | Std. Deviation | Sig. |
|---|---|---|---|---|
| Pre Test DTF& DSET | 27.60 | 10 | 4.402 | 0,000* |
| Post Test DTF& DSET | 5.80 | 10 | 3.327 | |

*Note:* $p < 0.05$ indicates statistical significance.

Based on Table 3, which was analyzed using the paired sample t-test, a *p*-value of 0.000 was obtained ($p < 0.05$). This indicates that the combination of DTF and DSET had a significant effect on improving cervical function among workers with neck pain. The combination of DSET and DTF provides significant physiological effects in muscle rehabilitation as well as improvements in muscular and cardiorespiratory fitness. Dynamic Strength-Endurance Training (DSET) is a combination of strength and endurance exercises that induces neuromuscular adaptations, such as alterations in the biophysical properties of motor neurons, increased muscle capillarization, and transformation of motor units to become more fatigue-resistant. This training also enhances the oxidative capacity of muscles and reduces glycolytic ATP production, thereby helping to delay muscle fatigue. Furthermore, DSET increases voluntary contraction strength and maximal motor unit discharge, which can reduce stress on cervical structures and alleviate pain by increasing endogenous opioid production and improving tissue metabolism, including that of the intervertebral discs (Priya et al., 2023).

Deep transverse friction (DTF) operates through complex physiological mechanisms, including stimulation of mechanoreceptors that generate afferent impulses, producing temporary analgesia via neurotransmitter depletion and transient local blood flow blockade, followed by increased oxygenated blood flow (Chamberlain, 2025). In addition to an analgesic effect that may last up to 24 hours, DTF stimulates fibroblastic proliferation and realignment of collagen fibers according to the applied pressure, thereby promoting tissue remodeling during the inflammatory, proliferative, and remodeling

phases (Chaves et al., 2017). This is supported by Choksi et al., (2021), who demonstrated the effectiveness of DTF in reducing pain at trigger points.

### 3.4. Difference in the Effects of DTF Combined with WE and DSET on Cervical Function

The analysis of the differences in the effects of DTF combined with WE and DSET on cervical function among workers experiencing neck pain is presented in Table 4 below:

**Table 4.** Differences in the Effects of DTF Combinations on WE and DSET on Neck Function

| | Mean Difference | Std. Error Difference | Sig.(2-tailed) |
|---|---|---|---|
| Post Test DTF& WEdan DTF& DSET | 2.400 | 1.603 | 0.152 |

Table 4 presents the analysis to determine the difference in effectiveness between the combination of DTF with WE and DSET on cervical function among workers with neck pain. The analysis was performed using an Independent Sample T-Test. The results showed a p-value of 0.152 ($p > 0.05$), indicating that there was no significant difference in effectiveness between the two intervention combinations in improving cervical function. The difference in effectiveness between WE and DSET is strongly influenced by the type of occupation and the physical characteristics of the patient. Workplace Exercise (WE) is more effective for office workers who remain in static positions for prolonged periods and experience high levels of fatigue, as it is practical, easily accessible, and can be performed at light to moderate intensity (Shariat et al., 2018). Conversely, DSET requires higher energy and stamina, making it less suitable for individuals with chronic fatigue. However, DSET is more relevant for physically demanding occupations such as construction or manufacturing, as it supports muscle strength and endurance, provided that it is tailored to the individual's fitness level and work schedule (Evans, 2019).

The effectiveness of these interventions is also highly dependent on occupational profiles. According to Chen et al., (2018) WE is superior for professions involving static activities because it can be implemented in a short time without disrupting productivity, whereas physically demanding jobs require more intensive approaches that account for the body's capacity. In the present study, the assessment used was limited to the Neck Disability Index (NDI) questionnaire, which does not fully reflect the patient's overall condition. Therefore, additional evaluations are recommended, such as the Multidimensional Fatigue Inventory (MFI-20) to identify fatigue levels (Shahid et al., 2017), the Work Ability Index (WAI) to assess work capacity (El Fassi et al., 2019), and the Fear-Avoidance Beliefs Questionnaire (FABQ) to evaluate pain perception (Villotti et al., 2024). The results of these assessments would help determine the most appropriate and safe intervention for each individual.

## 4. Conclusion

This study demonstrates that both the combination of DTF with WE and the combination of DTF with DSET are equally effective in improving neck function among workers with neck pain. Although no significant difference was found between the two interventions, each has distinct mechanisms of action and can be tailored to the needs of the patient or specific work conditions. These findings contribute to evidence-based physiotherapy practice for managing musculoskeletal disorders in workers. The prospective development of this research lies in the implementation of long-term interventions and the evaluation of their effectiveness in populations with different occupational types. Furthermore, future studies may consider assessing quality of life and cost-efficiency in the application of these combined therapies within broader workplace settings.

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## References

Chamberlain, G. J. (2025). Cyriax's friction massage: A review. *Journal of Orthopaedic and Sports*

*Physical Therapy*, *4*(1), 16–22. https://doi.org/10.2519/jospt.1982.4.1.16

Chaves, P., Simões, D., Paço, M., Pinho, F., Duarte, J. A., & Ribeiro, F. (2017). Cyriax's deep friction massage application parameters: Evidence from a cross-sectional study with physiotherapists. *Musculoskeletal Science and Practice*, *32*, 92–97. https://doi.org/10.1016/j.msksp.2017.09.005

Chen, X., Coombes, B. K., Sjøgaard, G., Jun, D., O'Leary, S., & Johnston, V. (2018). Workplace-based interventions for neck pain in office workers: Systematic review and meta-analysis. *Physical Therapy*, *98*(1), 40–62. https://doi.org/10.1093/ptj/pzx101

Choksi, K., Chauhan, S., Jaria, S., & Agrawal, A. (2021). Effect of Deep Transverse Friction Massage and Ischemic Compression in Trapezitis: A Randomized Controlled Trial. *Indian Journal of Physiotherapy and Occupational Therapy - An International Journal*, *15*(1), 47–53. https://doi.org/10.37506/ijpot.v15i1.13347

Dewi, K. L. P., Adiputra, N., Muliarta, I. M., Tirtayasa, K., Adiatmika, I. P. G., & Adnyana, I. W. B. (2018). Pemberian Workplace Stretching Exercise Dan Modifikasi Kondisi Kerja Dapat Menurunkan Keluhan Muskuloskletal Dan Kelelahan Pada Pekerja Pembuat Dodol Tradisional Di Desa Tamblang – Kabupaten Buleleng. *Jurnal Ergonomi Indonesia (The Indonesian Journal of Ergonomic)*, *4*(1), 11–17. https://doi.org/10.24843/jei.2018.v04.i01.p02

Diani, N., & Hafifah, I. (2019). Hibungan Umur, Jenis Kelamin, Masa Kerja Dan Kebiasaan Olahraga Dengan Keluhan Musculoskeletal Disorders (Msds) Pada Perawat. *CNJ: Caring Nursing Journal*, *3*(1), 23–30.

El Fassi, M., Bocquet, V., Majery, N., Lair, M. L., Couffignal, S., & Mairiaux, P. (2019). Work ability assessment in a worker population: Comparison and determinants of Work Ability Index and Work Ability score. *BMC Public Health*, *13*(1), 1–10. https://doi.org/10.1186/1471-2458-13-305

Evans, J. W. (2019). Periodized resistance training for enhancing skeletal muscle hypertrophy and strength: A mini-review. *Frontiers in Physiology*, *10*(JAN), 1–7. https://doi.org/10.3389/fphys.2019.00013

I Putu Mahendra Putra, Made Hendra Satria Nugraha, & Ni Wayan Tianing. (2020). Combined Deep Transverse Friction and Muscle Energy Technique on Mechanical Neck Pain: Article Review. *Physical Therapy Journal of Indonesia*, *1*(1), 17–22. https://doi.org/10.51559/ptji.v1i1.5

Izquierdo, M., Merchant, R. A., Morley, J. E., Anker, S. D., Aprahamian, I., Arai, H., Aubertin-Leheudre, M., Bernabei, R., Cadore, E. L., Cesari, M., Chen, L. K., de Souto Barreto, P., Duque, G., Ferrucci, L., Fielding, R. A., García-Hermoso, A., Gutiérrez-Robledo, L. M., Harridge, S. D. R., Kirk, B., … Singh, M. F. (2021). International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. *Journal of Nutrition, Health and Aging*, *25*(7), 824–853. https://doi.org/10.1007/s12603-021-1665-8

Jahre, H., Grotle, M., Smedbråten, K., Dunn, K. M., & Øiestad, B. E. (2020). Risk factors for non-specific neck pain in young adults. A systematic review. *BMC Musculoskeletal Disorders*, *21*(1), 1–12. https://doi.org/10.1186/s12891-020-03379-y

Jufri, & Indriani. (2023). Hubungan Waktu Kerja Dan Masa Kerja Dengan Risiko Keluhan Nyeri Leher (Neck Pain) Pada Pekerja Operator Komputer Di PT. Sucofindo Makassar Tahun 2022. *Jurnal Mitrasehat*, *12*(2), 241–247. https://doi.org/10.51171/jms.v12i2.337

Kazeminasab, S., Nejadghaderi, S. A., Amiri, P., Pourfathi, H., Araj-Khodaei, M., Sullman, M. J. M., Kolahi, A. A., & Safiri, S. (2022). Neck pain: global epidemiology, trends and risk factors. *BMC Musculoskeletal Disorders*, *23*(1), 1–13. https://doi.org/10.1186/s12891-021-04957-4

Khusnaini, A., Rosida, L., ST, S., Kes, M. K. M., Yani, F., ST, S. S. T., & Fis, M. (2020). *Pengaruh Pemberian Muscle Energy Technique Dan Isometrik Exercise Terhadap Peningkatan Aktifitas Fungsional Nyeri Leher: Narrative Review*.

Koch, M., L-k, L., Forsman, M., Ll, A., Enquist, H., Sjøgaard, G., Søgaard, K., Fan, X., & Kb, V. (2025). *neck pain ? A meta-analysis of a pooled dataset*. 0–10. https://doi.org/10.5271/sjweh.4227

Luik, S. A., Ratu, J. M., & Setyobudi, A. (2021). The Effect of Workplace Stretching Exercise on Reducing Musculoskeletal Complaints in Ndao Ikat Weaving Workers in Rote Ndao District. *Lontar: Journal of Community Health*, *3*(3), 133–140.

Mujiono, M., Udijono, A., & Rahmaningrum, F. D. (2023). Description of Work Related Neck Pain Among Employees in State Electricity Company (PLN Indonesia). *Journal of Public Health for Tropical and Coastal Region*, *6*(1), 1–6.

Nurhidayanti, O., Hartati, E., & Handayani, P. A. (2021). Pengaruh Mckenzie Cervical Exercise terhadap Nyeri Leher Pekerja Home Industry Tahu. *Holistic Nursing and Health Science*, *4*(1), 34–43. https://doi.org/10.14710/hnhs.4.1.2021.34-43

Panggabean, R. I., & Pujiastuti, R. A. D. (2021). Perbandingan antara Penggunaan Tas Ransel dan Tas Sandang dengan Kejadian Nyeri Leher pada Mahasiswa Fakultas Kedokteran Universitas Sumatera Utara Angkatan 2016-2018. *SCRIPTA SCORE Scientific Medical Journal*, *3*(1), 23–33. https://doi.org/10.32734/scripta.v3i1.5564

Petré, H., Hemmingsson, E., Rosdahl, H., & Psilander, N. (2021). Development of maximal dynamic strength during concurrent resistance and endurance training in untrained, moderately trained, and trained individuals: a systematic review and meta-analysis. *Sports Medicine*, *51*, 991–1010.

Priya, S., Haripriya, S., & Dhungana, M. (2023). *strength - endurance training of the pain and improving function in*. 60–64. https://doi.org/10.4103/pjiap.pjiap

Putri, G. A., Dyah, W. A., & Awanis, A. (2023). Pengaruh Pemberian Workplace Exercise terhadap Neck Pain pada Perajin Batik Tulis. *FISIO MU: Physiotherapy Evidences*, *4*(2), 82–88. https://doi.org/10.23917/fisiomu.v4i2.22137

Qu, N., Tian, H. C., De Martino, E., & Zhang, B. (2022). Neck Pain: Do We Know Enough About the Sensorimotor Control System? *Frontiers in Computational Neuroscience*, *16*(July), 1–10. https://doi.org/10.3389/fncom.2022.946514

Sari, R. O., & Rifai, M. (2019). Hubungan Postur Kerja dan Masa Kerja dengan Keluhan Muculoskeletal Disorders (MSDs) pada Pembatik Giriloyo di Kabupaten Bantul. *Naskah Publikasi. Yogyakarta: Universitas Ahmad Dahlan*, 1–15.

Shahid, A., Wilkinson, K., Marcu, S., & Shapiro, C. M. (2017). STOP, THAT and one hundred other sleep scales. *STOP, THAT and One Hundred Other Sleep Scales*, 1–406. https://doi.org/10.1007/978-1-4419-9893-4

Shariat, A., Cleland, J. A., Danaee, M., Kargarfard, M., Sangelaji, B., & Tamrin, S. B. M. (2018). Effects of stretching exercise training and ergonomic modifications on musculoskeletal discomforts of office workers: a randomized controlled trial. *Brazilian Journal of Physical Therapy*, *22*(2), 144–153. https://doi.org/10.1016/j.bjpt.2017.09.003

Situmorang, C. K., Widjasena, B., & Wahyuni, I. (2020). Hubungan antara durasi dan postur tubuh penggunaan komputer terhadap keluhan neck pain pada tenaga kependidikan fakultas kesehatan masyarakat universitas diponegoro. *Jurnal Kesehatan Masyarakat*, *8*(5), 672–678.

Tarwaka. (2016). *Dasar-dasar Keselamatan Kerja Serta Pencegahan Kecelakaan di Tempat Kerja*. Harapan Press.

To, K. E., Berek, N. C., & Setyobudi, A. (2020). Hubungan Masa Kerja, Jenis Kelamin dan Sikap Kerja dengan Keluhan Muskuloskeletal pada Operator SPBU di Kota Kupang. *Media Kesehatan Masyarakat*, *2*(2), 42–49.

Utami, U., Karimuna, S. R., & Jufri, N. (2017). Hubungan Lama Kerja, Sikap Kerja dan Beban Kerja Dengan Muskuloskeletal Disorders (MSDs) pada Petani Padi di Desa Ahuhu Kecamatan Meluhu Kabupaten Konawe Tahun 2017. *Jurnal Ilmah Mahasiswa Kesehatan Masyarakat*, *2*(6), 1–10.

Villotti, P., Kordsmeyer, A. C., Roy, J. S., Corbière, M., Negrini, A., & Larivière, C. (2024). Systematic review and tools appraisal of prognostic factors of return to work in workers on sick leave due to musculoskeletal and common mental disorders. *PLoS ONE*, *19*(7 July), 1–28. https://doi.org/10.1371/journal.pone.0307284

Weerakoon, T. C. S., Dissanayake, P. H., Jayakody, S., Weerasekera, M. M., & Yasawardene, S. G. (2021). Intensity of neck pain and its association with anthropometric measurements. *Sri Lanka Anatomy Journal*, *5*(1), 19–28. https://doi.org/10.4038/slaj.v5i1.130