The Indonesian Journal of Occupational Safety and Health
2024, 13 (3): 295-303
p ISSN: 2301 8046, e ISSN: 2540 7872
http://doi.org10.20473/ijosh.v13i3.2024.295-303

ORIGINAL ARTICLE

Evaluation of Musculoskeletal Loads and Pain in Physical Therapists Treating Neurological Patients

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ABSTRACT

Introduction: Work-related musculoskeletal disorders (WRMDs) are one of the major health problems among physical therapists treating neurological patients. Therefore, this study aimed to determine the risk factors for developing WRMDs in physical therapists in South Korea treating neurological patients. **Methods:** This research is an analytical observational study with a cross-sectional design. In this study, 30 physical therapists who treat neurological patients were recruited by randomly selecting respondents to flyers posted throughout the hospital. To evaluate risk levels, during the transfer of the patient from the wheelchair to the treatment table and during treatment, the Rapid Entire Body Assessment (REBA) was performed. Moreover, physical therapists were assessed for musculoskeletal symptoms through the Nordic Musculoskeletal Questionnaire (NMQ) survey. **Results:** The findings revealed that during the treatment session, the REBA score was 43.33% for medium and high risk level and 13.33% for very high risk level. Meanwhile, during the transfer session, the REBA score was 40% for high risk level and 60% for very high risk level. The results of the Nordic musculoskeletal questionnaire showed that physical therapists felt significant pain in the wrist/hand, shoulders, neck, lower back, and knee. **Conclusion:** Physical therapists treating neurological patients have a high risk of developing WRMDs. Thus, changes need to be made regarding the working pattern of physical therapists, and more detailed evaluations of ergonomic risk factors are required.

Keywords: nordic musculoskeletal questionnaire, pain, physical therapist, REBA, WRMDs

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INTRODUCTION

Physical therapists help stroke patients rebuild strength, coordination, and balance to enable them to perform daily tasks like walking, dressing, and bathing (Shen *et al*., 2023). This therapy typically includes a combination of exercises, stretching routines, and range of motion activities. Additionally, they provide training to improve mobility and walking skills, enhancing the patient's independence and safety (O'Brien *et al*., 2023). These interventions commonly include manual handling, transfer assistance, passive range of motion exercises, and other hands-on techniques that place substantial musculoskeletal loads on the therapists (Shah and Desai, 2022). As a result, physical therapists are at a high risk of developing work-related musculoskeletal disorders (WRMDs), including back pain, neck pain, and upper limb disorders, which can adversely affect their ability to work effectively and provide high-quality patient care.

Musculoskeletal disorders refer to pathological injuries of the body that can affect its overall function (Prall and Ross, 2019). WMSDs encompass a range of inflammatory or degenerative conditions that involve pathological injuries to bones, ligaments, cartilage, joints, muscles, nerves, the vertebral column, and the vascular system (Parno *et al*., 2017).

Recent studies have highlighted that physical therapists, especially those working in neurological rehabilitation, are frequently exposed to biomechanical stressors that exceed safe limits, leading to a high prevalence of musculoskeletal pain and injuries.

Among physical therapists, the prevalence of WRMDs is reported to be exceeded 80% (Kinaci and Ataoğlu, 2020). These disorders are the most

Cite this as: *Jeon, H. and Lee, D. (2024) 'Evaluation of Musculoskeletal Loads and Pain in Physical Therapists Treating Neurological Patients, The Indonesian Journal of Occupational Safety and Health, 13(3), pp. 295-303*

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common health problem amongst physical therapists, with the neck, lower back, shoulders, wrists, and ankles being the most affected body parts (Khairy *et al*., 2019).

Low back pain is the common issue among physiotherapists (Alnaser and Aljadi, 2019). The one-year prevalence of low back pain ranges from 6.6% to 83%, mainly due to repeated lifting, transferring, twisting, bending, or prolonged standing (Anderson and Oakman, 2016). Physiotherapists using manual and orthopedic techniques are particularly vulnerable to pain in the neck, wrist, palm, and thumb (Shah and Desai, 2022).

A previous study reported that the most frequently diagnosed injuries were hand muscle tendonitis (26.2%), joint inflammation (23.4%), and hand joint arthrosis (17.8%) (Škrečková *et al*., 2023). Another study found a 22.7% prevalence of osteoarthritis in the hand region and a 6.4% prevalence of joint hypermobility among physical therapists (Snodgrass *et al*., 2003).

These MSDs often cause work stoppages (Kinaci and Ataoğlu, 2020), prompting some physical therapists to change their workplace to avoid re-injury or even consider changing their profession altogether (Khairy *et al*., 2019).

Furthermore, physical therapists treating neurological patients often perform tasks in awkward postures, engage in repetitive motions, and lift or support significant patient weight, all of which contribute to increased risk of musculoskeletal overload (Milhem *et al*., 2016). These physical demands are further exacerbated by the chronic nature of neurological conditions, requiring physical therapists to provide long-term, intensive care.

Although physical therapists have adequate knowledge regarding musculoskeletal injuries and methods to prevent them, they are less likely to report their injuries or seek care as they rely on self-treatment based on their clinical (Prall and Ross, 2019). A previous study found that the risk of musculoskeletal disorders among physical therapist increases during patient transfer and repositioning, frequent trunk flexion and rotation, and awkward postures (Vinstrup *et al*., 2020).

Physical therapy is a physically demanding profession that involves repetitive works, such as manual skills requiring significant force to treat patients, methods that apply direct pressure on specific joints and uncomfortable joint positioning during treatment (Le *et al*., 2024).

Physical therapists specializing in neurological patients are experienced and trained to treat neurological conditions, focusing on interventions that help individuals regain or maintain optimal movement and functional independence. Their treatment methods include joint mobilization, stretching, strengthening, spasticity controlling, gait and balance training. Gait retraining, in particular, demands significant effort from the physical therapist, as they must manually assist the patient with stepping while also maintaining their balance and posture (Masiero *et al*., 2014).

Common neurological conditions such as stroke, multiple sclerosis, spinal cord injury, Parkinson's disease, and head injuries tend to increase patient dependency, especially during the acute phase. As a result, physical therapists in hospital environments are more likely to perform patient lifts and transfers, which require more physical exertion (Shah and Desai, 2022).

Research has confirmed that physical therapists treating neurological patients are at a higher risk of developing WMSDs, particularly in the lower back, upper back, buttocks, thighs, and legs. This increased risk is due to the greater dependency of patients with neurological disorders, who often require assistance with transfers, lifting, and repositioning (Alghadir *et al*., 2017).

The Rapid Entire Body Assessment (REBA) is used as a tool to measure fatigue during work. Moreover, it has been used to assess and analyze posture in previous studies. Aside from being easy to use, REBA can be used to assess abnormalities in all parts of the body and task risk (Hita-Gutiérrez *et al*., 2020).

At present, various studies have used REBA to evaluate musculoskeletal injuries in workers (Raman *et al*., 2020; Karelia, Rathod and Kumar, 2021; George and Abraham, 2022).

However, few studies have investigated the risk factors for developing WRMDs among physical therapists.

Of the studies conducted on the risk of WRMDs among physical therapists (Cornwell *et al*., 2020; Abu-Taleb and Rehan Youssef, 2021; Fan *et al*., 2022), few have investigated WRMDs among physical therapists treating neurological patients.

Physical therapists who treat neurological patients often quit or change jobs due to WRMDs. Despite this issue, there is a lack of research on the musculoskeletal risks faced by physical therapists treating neurological patients. Therefore, the

present study aimed to determine the risk factors for developing WRMDs in physical therapists treating neurological patients.

METHODS

This observational descriptive study with a cross-sectional design was conducted in April 2024 at the Department of Physical Therapy in Suwon Centum Hospital. The study was conducted under the approval of the institutional review board of U1 University (U1IRB2024-03), and all participants provided written informed consent before taking part. Among physical therapists who responded to flyers that were placed throughout the hospital, 30 participants were randomly selected. The criteria for inclusion were: physical therapists with a minimum of two years' experience in treating neurological patients, specifically those with stroke or spinal cord injuries.

REBA was employed to assess musculoskeletal risk factors for the entire body in relation to various tasks (Figure 1). REBA utilizes a structured approach to evaluate the risk of musculoskeletal disorders associated with the task under review (Joshi and Deshpande, 2020). The risk assessment of musculoskeletal diseases was analyzed using the REBA sheet, and the results were divided into different categories: low risk (a score of 2–3), medium risk (a score of 4–7), and high risk (a score of 8–10). REBA was separately performed during patient transfer from the wheelchair to the table and during treatment.

The pain experienced by subjects with various joint conditions, such as in the neck, back, shoulders, and extremities, was assessed using the Nordic Musculoskeletal Questionnaire (NMQ), a validated tool designed to examine the prevalence and effects of work-related musculoskeletal symptoms (Kakaraparthi *et al*., 2023). This questionnaire asks respondents whether they have experienced any musculoskeletal issues in the past 12 months or the last seven days that have interfered with their normal activities.

A bivariate analysis using the Spearman correlation test was conducted to examine the relationship between the independent variables (sex and work experience) and the dependent variable (body pain).

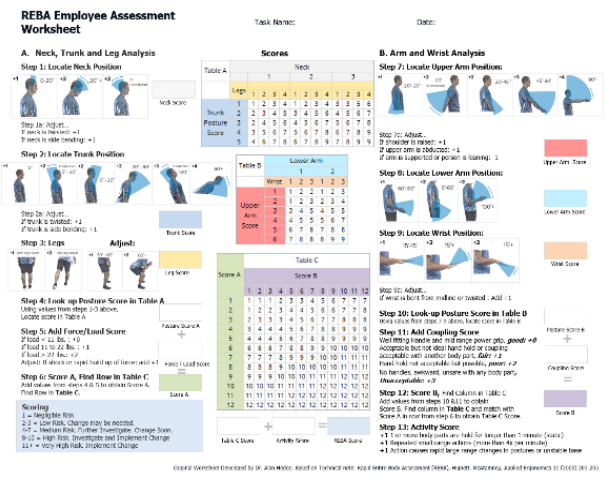

Figure 1. REBA Worksheet

RESULT

All 30 physical therapists responded to the questionnaire. Table 1 shows the characteristics of subjects. The REBA score was recorded for each session during patient treatment and transfer.

REBA Score

As indicated in Table 2, the REBA score was 43.33% for medium and high risk level and 13.33% for very high risk level during the treatment session. Meanwhile, the REBA score was 40% for high risk level and 60% for very high risk level during the transfer session.

Nordic Musculoskeletal Questionnaire (NMQ)

As shown in Table 3, among the respondents who reported musculoskeletal discomfort in the

Table 1. Characteristics of Subjects

Variable	Mean ± SD
Sex (M/F)	15/15
Age (years)	30.67±3.43
Weight (Kg)	169.48±8.33
Height (Cm)	65.23±14.30
Work experience (years)	5.40±2.11
Work time (min/day)	346.00±24.17

Table 2. Results of REBA Risk Level

Risk level	Treatment	Transfer
Negligible	0	0
Low	0	0
Medium	13 (43.33%)	0
High	13 (43.33%)	12 (40%)
Very high	4 (13.33%)	18 (60%)

previous seven days, wrist/hand discomfort was the most common (87%), followed by shoulder discomfort (83%), lower back discomfort (70%), neck discomfort (67%), knee discomfort (33%), ankle/foot discomfort (27%), upper back discomfort (13%), hip/thigh discomfort (7%), and elbow discomfort (2%).

Among the respondents who reported musculoskeletal discomfort in the previous 12 months, wrist/hand discomfort and lower back discomfort were the most common (97%), followed by shoulder discomfort (87%), neck discomfort (83%), knee discomfort (67%), upper back discomfort (53%), ankle/foot discomfort (43%), hip/thigh discomfort (17%), and elbow discomfort (17%).

Table 3. Results of the NMQ

Body part		Previous 7 days	Previous 12 Months
Neck	Yes	20 (67)	25 (83)
	No	10 (33)	5 (17)
Shoulder	Yes	25 (83)	26 (87)
	No	5 (17)	4 (13)
Elbows	Yes	2 (7)	5 (17)
	No	28 (93)	25 (83)
Wrist/Hand	Yes	26 (87)	29 (97)
	No	4 (13)	1 (3)
Upper back	Yes	13 (43)	16 (53)
	No	17 (57)	14 (47)
Lower back	Yes	21 (70)	29 (97)
	No	9 (30)	1 (3)
Hips/Thighs	Yes	2 (7)	5 (17)
	No	28 (93)	25 (83)
Knees	Yes	10 (33)	20 (67)
	No	20 (67)	10 (33)
Ankle/Feet	Yes	8 (27)	13 (43)
	No	22 (73)	17 (57)

All values are presented as No. (%)

Table 4. Correlation between Body Pain, Sex, and Work Experience in Previous 12 Months

Body Part	Sex (r-value)	Work Experience (r-value)
Neck	-.268	-.383*
Shoulder	.392*	-.293
Elbows	.447*	-.540*
Wrist/Hand	.186	-.109
Upper back	.668*	-.145
Lower back	.186	.120
Hips/Thighs	-.089	-.335
Knees	.424*	-.588*
Ankle/Feet	.336	-.083

The Correlation between Body Pain, Sex, and Work Experience in Previous 12 Months

There was a significant correlation between the shoulder (r = .392), elbow (r = .447), upper back (r = .668), knees (r = .424), and sex (p-value < 0.05). However, there was no significant correlation between the neck (r = -.268), wrist/hand (r = .186), lower back (r = .186), hips/thighs (r = -.089), ankle/feet (r = .336), and sex (p-value > 0.05).

Since the r values were positive for the significant correlations, this indicates a positive relationship. This means that women experienced statistically significantly more pain in the shoulder, elbow, upper back, and knee areas than men.

There was a significant correlation between the neck (r = -.383), elbow (r = -.540), knees (r = -.588), and work experience (p-value < 0.05). However, there was no significant correlation between the shoulder (r = -.293), wrist/hand (r = -.109), upper back (r = -.145), lower back (r = .120), hips/thighs (r = -.335), ankle/feet (r = -.083), and work experience (p-value > 0.05).

Since the r values for the significant correlations were negative, this indicates a negative relationship. This suggests that individuals with fewer years of work experience experienced statistically significantly more pain in the neck, elbow, and knees.

DISCUSSION

This study aimed to identify the risk factors for developing WRMDs in physical therapists treating neurological patients. Most previous studies on WRMDs only used questionnaires, and few analyzed the risk factors for WRMDs in physical therapists treating neurological patients. In this study, the REBA scores were analyzed by dividing the work of physical therapists into therapy and patient transfer sessions.

The results showed that all physical therapy practices have a non-negligible ergonomic risk in all treatment and transfer sessions. During the treatment session, the REBA score was 43% for the median and high risk level and 14% for the very high risk level. During the patient transfer session, the REBA score was 40% for the high risk level and 60% for

the very high risk level. A score with a very high risk level indicates that immediate action is needed to control the risk.

In particular, transferring neurological patients is a high risk task associated with WRMDs for physical therapists. In this study, physical therapists treated patients with stroke and spinal cord injuries. Individuals with spinal cord injuries experience partial or complete loss of sensory and/or motor function below the site of injury (Mostafa, Plastow and Savin-Baden, 2020). Meanwhile, most stroke patients have difficulty performing basic activities of daily living due to sensory, motor, and cognitive impairments (Lee *et al*., 2021). Therefore, physical therapists treating neurological patients perform more patient transfer tasks than those treating patients without neurological disorders. Physical therapists were more likely to perform lifting and transferring when treating inpatients than outpatients. These tasks place a significant load on the musculoskeletal system, increasing the risk of back pain and injury (Vinstrup *et al*., 2020).

Lifting or transferring patients, as well as maintaining poor posture or awkward positions, were identified as the primary causes of neck and lower back pain across various professions, including among physical therapists. Our results are consistent with earlier research, which highlighted that tasks like lifting or carrying patients, staying in one position for extended periods, or working in twisted or uncomfortable postures significantly elevate the risk of developing neck and lower back issues in physical therapists (Le *et al*., 2024).

Training in functional activities, such as ADLs (activities of daily living), gait, and stair navigation, has been closely linked to neck and lower back issues among physical therapists (Le *et al*., 2024). This connection can be attributed to the extended periods of standing, along with the frequent twisting and bending involved when assisting patients with ADLs, walking, and stair climbing (Nordin, Leonard and Thye, 2011). These physical demands frequently contribute to neck, upper extremity, and lower back issues in this profession.

The NMQ results revealed that physical therapists experience a high rate of musculoskeletal pain. In particular, physical therapists felt significant pain in the wrist/hand, shoulders, neck, lower back, and knees. An earlier study revealed that the highest prevalence rates were in the lower back (40.1%), thumb (35.4%), neck (26.4%), and shoulder (20.8%) (Gorce and Jacquier-Bret, 2023).

In another study, repeated manual therapy, female sex, and less than five years of experience were found to be risk factors for wrist/hand pain (Vieira *et al*., 2016). A previous study suggested that WRMDs are associated with repeated movements, forces, and/or persistent postures through soft tissue and joint mobilization (Gonçalves *et al*., 2022).

The results of this study found a statistically significant correlation between body pain, sex, and work experience, with less work experience being associated with more severe pain in the neck, elbow, and knees. Additionally, women experienced significantly more pain in the shoulder, elbow, upper back, and knee areas compared to men.

However, as this study had a small sample size (30 subjects), the results cannot be generalized, and future research should involve a larger number of participants.

Physical therapists primarily use their hands in their work to therapeutically impact the human body. Nearly all procedures performed on patients' bodies are transmitted directly back through the physical therapist's hands. Techniques that involve the excessive, repetitive use of the hands in unnatural angular positions can lead to joint and muscle pain. Prolonged excessive stress on the hands leads to structural changes, resulting in nerve, joint, and bone damage that can already cause incapacity for work (Škrečková *et al*., 2023).

Therapists experience touches, pressures, pulls, movements, and vibrations on their own bodies. This is due to the nature of manual physical therapy techniques, which can cause wear and tear or even damage to the wrist and hand structures, potentially leading to reduced work performance and increased absences (Milhem *et al*., 2016).

Moreover, the highest prevalence was observed in younger physical therapists, and the initial onset of lower back pain was most commonly within the first four years of work (Chiwaridzo, Chamarime and Dambi, 2018). The main cause of back pain is the nature of the occupation. Physical therapy involves repetitive work, high-intensity manual skills to bend or twist postures, moving patients to support the activities, and heavy lifting of equipment (Tembo *et al*., 2023). WMSDs were more prevalent among individuals with younger age and fewer years of experience, possibly due to their improper handling and treatment techniques (Girbig *et al*., 2017).

In this study, the subjects had five years of experience in physical therapy. For this reason, it is thought that they have experienced musculoskeletal

pain. This result, however, was not observed in previous studies. To obtain a license and work independently, Slovenian physical therapists essential complete a 6-month internship program. During this period, they absorb how to protect their bodies effectively while performing physical therapy procedures (Meh *et al*., 2020).

Additionally, we found that physical therapists perform kneeling postures during physical therapy. Kneeling is regarded as a significant risk factor for conditions like osteoarthritis, bursitis, and meniscal injuries (Bahns *et al*., 2021). A previous study indicated that the static load on the knee ranges from 22% to 68% of body weight when one or both knees are in a kneeling position, depending on the posture (Jensen, Rytter and Bonde, 2010). The combination of high forces applied to the knee and significant kneeling time can accelerate cartilage wear, thereby leading to osteoarthritis and semilunar cartilage damage (Tennant *et al*., 2015). Hence, when treating patients, physical therapists should avoid kneeling as much as possible.

More broadly, posture emerged as a key factor in both the risk of developing MSDs and the strategies proposed to mitigate them. Performing daily tasks in awkward postures, particularly when they are repetitive and prolonged, increases the risk of musculoskeletal disorders (MSDs). To minimize joint and muscle strain, it is crucial to assess these risk factors while following basic ergonomic principles, such as maintaining postures near joint neutrality (Jacquier-Bret and Gorce, 2023).

In this study, the physical therapists treated one patient for 30 min in a single session, and they treated an average of 11 patients per day. Our study revealed that an excessive number of patients treated daily by a single physical therapist, identified in the literature (Meh *et al*., 2020) as a risk factor, was also confirmed as such in our study sample. Therefore, they may not be getting enough rest, leading to musculoskeletal pain.

Earlier studies have indicated that performing repetitive tasks and continuing to work despite having musculoskeletal injuries more than doubles the risk of developing lower back problems. This is due to the sustained stress placed on soft tissues over time (Chen *et al*., 2022). An increased workload, limited time, and inadequate recovery naturally contribute to structural changes and the gradual development of specific disorders. These factors restrict activity and decrease both performance and its quality. Initial fatigue-related pains are often ignored. Muscle pain is primarily caused by repetitive, long-term activities involving unilateral isometric muscle load (Wajon and Ada, 2003). Thus, previous researchers recommend a rational distribution of break and work time of physical therapists that contributes to muscle recovery (Chegini, Ghousi and Sadeghi Naeini, 2021). Many physical therapists do not report work-related injuries. Additionally, they underestimate the severity of the injuries, believing they can resolve them on their own.

The present study has several limitations. First, the sample size is small. Therefore, the results could not be generalized. Second, the patient's disease or functional level was not classified. Future studies will need to be conducted considering these limitations.

By understanding the unique physical demands faced by physical therapists in neurological settings, this research aims to contribute to the reduction of work-related musculoskeletal disorders and improve the overall health of these healthcare professionals, ultimately enhancing the quality of treatment provided to neurological patients.

CONCLUSION

Physical therapists treating neurological patients have a very high risk of developing musculoskeletal disorders. Thus, the risk of musculoskeletal disorders needs to be assessed in detail for all physical therapists treating neurological patients, and changes need to be made regarding the working pattern of physical therapists.

CONFLICT OF INTEREST

We have no conflict of interest to disclose.

ACKNOWLEDGMENTS

The authors did not receive any financial support for this article.

REFERENCES

Abu-Taleb, W. and Rehan Youssef, A. (2021) 'Work-related Musculoskeletal Disorders among Egyptian Physical Therapists', *Bulletin of Faculty of Physical Therapy*, 26(1). https://doi.org/10.1186/S43161-021-00025-Z.

Alghadir, A. *et al*. (2017) 'Work-Related Low Back Pain among Physical Therapists in

Riyadh, Saudi Arabia', *Workplace Health and Safety*, 65(8), pp. 337–345. https://doi.org/10.1177/2165079916670167.

Alnaser, M.Z. and Aljadi, S.H. (2019) 'Physical Therapists with Rork-related Musculoskeletal Disorders in the State of Kuwait: A Comparison Across Countries and Health Care Professions.', *Work*, 63(2), pp. 261–268. https://doi.org/10.3233/WOR-162927.

Anderson, S.P. and Oakman, J. (2016) 'Allied Health Professionals and Work-Related Musculoskeletal Disorders: A Systematic Review', *Safety and Health at Work*, pp. 259–267. https://doi.org/10.1016/j.shaw.2016.04.001.

Bahns, C. *et al*. (2021) 'Occupational Risk Factors for Meniscal Lesions: A Systematic Review and Meta-analysis', *BMC Musculoskeletal Disorders*, 22(1). https://doi.org/10.1186/S12891-021-04900-7.

Chegini, A., Ghousi, R. and Sadeghi Naeini, H. (2021) 'Assessment of Isometric Muscle Exertion in Short-term Considering Task-rest Schedule', *Scientia Iranica*, 0(0), pp. 0–0. https://doi.org/10.24200/sci.2021.55731.4377.

Chen, C.Y. *et al*. (2022) 'Work-related musculoskeletal disorders among physical therapists in Taiwan', *Medicine (United States),* 101(7), p. E28885. https://doi.org/10.1097/MD.0000000000028885

Chiwaridzo, M., Chamarime, K.J. and Dambi, J.M. (2018) 'The Burden of Low Back Pain among Undergraduate Physiotherapy Students at the University of Zimbabwe: A Cross-sectional Study', *BMC Research Notes*, 11(1). https://doi.org/10.1186/S13104-018-3796-5.

Cornwell, L. *et al*. (2020) 'Work-related Musculoskeletal Disorders in Physical Therapists Attributable to Manual Therapy', *Journal of Manual and Manipulative Therapy*, pp. 1–7. https://doi.org/10.1080/10669817.2020.1793470.

Fan, L.J. *et al*. (2022) 'Ergonomic Risk Factors and Work-related Musculoskeletal Disorders in Clinical Physiotherapy', *Frontiers in Public Health*, 10. https://doi.org/10.3389/FPUBH.2022.1083609/FULL.

George, S.A. and Abraham, A.T. (2022) 'Work Related Musculoskeletal Risk Assessment Using REBA Assessment Tool in a Medical Doctor during COVID-19 Pandemic - A Case Study', *International Journal of Research and Review*, 9(3), pp. 217–221. https://doi.org/10.52403/ijrr.20220325.

Girbig, M. *et al*. (2017) 'Work-related Exposures and Disorders among Physical Therapists: Experiences and Beliefs of Professional Representatives Assessed using a Qualitative Approach', *Journal of Occupational Medicine and Toxicology*, 12(1). https://doi.org/10.1186/s12995-016-0147-0.

Gonçalves, H. *et al*. (2022) 'Assessment of Work-Related Musculoskeletal Disorders by Observational Methods in Repetitive Tasks—A Systematic Review', *Studies in Systems, Decision and Control*, 406, pp. 455–463. at: https://doi.org/10.1007/978-3-030-89617-1_41.

Gorce, P. and Jacquier-Bret, J. (2023) 'Global Prevalence of Musculoskeletal Disorders among Physiotherapists: A Systematic Review and Meta-Analysis', *BMC Musculoskeletal Disorders*, 24(1). https://doi.org/10.1186/S12891-023-06345-6.

Hita-Gutiérrez, M. *et al*. (2020) 'An Overview of REBA Method Applications in the World', *International Journal of Environmental Research and Public Health*. Available at: https://doi.org/10.3390/ijerph17082635.

Jacquier-Bret, J. and Gorce, P. (2023) 'Prevalence of Body Area Work-Related Musculoskeletal Disorders among Healthcare Professionals: A Systematic Review', *International Journal of Environmental Research and Public Health. MDPI*. https://doi.org/10.3390/ijerph20010841.

Jensen, L.K., Rytter, S. and Bonde, J.P. (2010) 'Exposure assessment of kneeling work activities among floor layers', *Applied Ergonomics*, 41(2), pp. 319–325. https://doi.org/10.1016/j.apergo.2009.08.004.

Joshi, M. and Deshpande, V. (2020) 'Investigative study and sensitivity analysis of Rapid Entire Body Assessment (REBA)', *International Journal of Industrial Ergonomics*, 79. https://doi.org/10.1016/j.ergon.2020.103004.

Kakaraparthi, V.N. *et al*. (2023) 'Clinical Application of Rapid Upper Limb Assessment and Nordic Musculoskeletal Questionnaire in Work-Related Musculoskeletal Disorders: A Bibliometric Study', *International Journal of Environmental Research and Public Health*. MDPI. https://doi.org/10.3390/ijerph20031932.

Karelia, B.J., Rathod, D. and Kumar, A. (2021) 'Assessment of Posture Related Musculoskeletal Risk Levels in Restaurant Chefs using Rapid Entire Body Assessment (REBA)', *International Journal of Health Sciences and Research*,

11(5), pp. 333–339. https://doi.org/10.52403/ijhsr.20210552.

Khairy, W.A. *et al*. (2019) 'Prevalence, Profile, and Response to Work-related Musculoskeletal Disorders among Egyptian physiotherapists', *Open Access Macedonian Journal of Medical Sciences*, 7(10), pp. 1692–1699. https://doi.org/10.3889/oamjms.2019.335

Kinaci, E. and Ataoğlu, S. (2020) 'Work Related Musculoskeletal Disorders Among the Physiotherapists: Sample of a Region in Turkey.', *Turkiye Klinikleri Journal of Health Sciences*, pp. 495–502. https://doi.org/10.5336/healthsci.2019-71762.

Lee, P.H. *et al*. (2021) 'Impacts of Stroke and Cognitive Impairment on Activities of Daily Living in the Taiwan Longitudinal Study on Aging', *Scientific Reports*, 11(1). https://doi.org/10.1038/s41598-021-91838-4.

Le, T.T.T. *et al*. (2024) 'Prevalence and Risk Factors of Work-related Musculoskeletal Disorders among Physical Therapists in Ho Chi Minh City, Vietnam', *BMC Public Health*, 24(1). https://doi.org/10.1186/S12889-023-17527-1.

Masiero, S. *et al*. (2014) 'The Value of Robotic Systems in Stroke Rehabilitation', *Expert Review of Medical Devices*, pp. 187–198. https://doi.org/10.1586/17434440.2014.882766.

Meh, J. *et al*. (2020) 'Work-related Musculoskeletal Disorders among Slovenian Physiotherapists', *Journal of Health Sciences*, 10(2), pp. 115–124. https://doi.org/10.17532/jhsci.2020.880.

Milhem, M. *et al*. (2016) 'Work-related Musculoskeletal Disorders among Physical Therapists: A Comprehensive Narrative Review', *International Journal of Occupational Medicine and Environmental Health*, pp. 735–747. https://doi.org/10.13075/ijomeh.1896.00620.

Mostafa, M. A., Plastow, N.A. and Savin-Baden, M. (2020) 'The Effectiveness of Spinal Cord Injury ADL Inpatient Education on Rehabilitation Outcomes: A Systematic Review and Meta-Analysis', *British Journal of Occupational Therapy*, 83(1), pp. 15–28. https://doi.org/10.1177/0308022619879019.

Nordin, N.A.M., Leonard, J.H. and Thye, N.C. (2011) 'Work-related Injuries among Physiotherapists in Public Hospitals-A Southeast Asian Picture', *Clinics*, 66(3), pp. 373–378. https://doi.org/10.1590/S1807-59322011000300002.

O'Brien, S.R. *et al*. (2023) 'Physical Therapist Clinical Reasoning in Home Care for Walking Assistive Device Prescription: A Description of Practice', *Physiotherapy Theory and Practice*, 39(1), pp. 80–88. https://doi.org/10.1080/09593985.2021.1996495.

Parno, A. *et al*. (2017) 'The Prevalence of Occupational Musculoskeletal Disorders in Iran: A Meta-Analysis Study', *Work*, 58(2), pp. 203–214. https://doi.org/10.3233/WOR-172619.

Prall, J. and Ross, M. (2019) 'The Management of Work-related Musculoskeletal Injuries in an Occupational Health Setting: The Role of the Physical Therapist', *Journal of Exercise Rehabilitation. Korean Society of Exercise Rehabilitation*, pp. 193–199. https://doi.org/10.12965/jer.1836636.318.

Raman, V. *et al*. (2020) 'Application of the Rapid Entire Body Assessment (REBA) in Assessing Chairside Ergonomic Risk of Dental Students', *British Dental Journal* [Preprint]. https://doi.org/10.1038/s41415-020-1855-5.

Shah, M.K. and Desai, R.G. (2022) 'Prevalence, Risk Factors and Prevention of Work-Related Musculoskeletal Disorders in Physiotherapist According to Their Specialization - A Review', *International Journal of Research and Review*, 9(3), pp. 485–495. https://doi.org/10.52403/ijrr.20220354.

Shen, J. *et al*. (2023) 'Effects of Virtual Reality-Based Exercise on Balance in Patients with Stroke: A Systematic Review and Meta-analysis', *American Journal of Physical Medicine and Rehabilitation*, 102(4), pp. 316–322. https://doi.org/10.1097/PHM.0000000000002096.

Škrečková, G. *et al*. (2023) 'Prevalence of Work-related Musculoskeletal Hand and Wrist Disorders in Physiotherapists', *Central European Journal of Public Health*, 31(3), pp. 178–183. https://doi.org/10.21101/cejph.a7767.

Suzanne J. Snodgrass *et al*. (2003) 'Factors related to Thumb Pain in Physiotherapists.', *Australian Journal of Physiotherapy*, 49(4), pp. 243–250.

Tembo, L.N. *et al*. (2023) 'Prevalence of Work-related Musculoskeletal Disorders and Associated Factors among University of Zimbabwe Faculty of Medicine and Health Sciences Non-academic Workers: A Cross-sectional Study', *BMC Musculoskeletal Disorders*, 24(1). https://doi.org/10.1186/S12891-023-06900-1.Tennant, L. *et al*. (2015) 'The Effect of Work Boots on Knee Mechanics and the Center of Pressure at the Knee during Static Kneeling', *Journal of Applied*

Biomechanics, 31(5), pp. 363–369. https://doi.org/10.1123/jab.2014-0276.

Vieira, E.R. *et al*. (2016) 'Work-related Musculoskeletal Disorders among Physical Therapists: A Systematic Review', *Journal of back and musculoskeletal rehabilitation*, 29(3), pp. 417–428. https://doi.org/10.3233/BMR-150649.

Vinstrup, J. *et al*. (2020) 'Physical Exposure during Patient Transfer and Risk of Back Injury & Low-back Pain: Prospective Cohort Study', *BMC Musculoskeletal Disorders*, 21(1). https://doi.org/10.1186/s12891-020-03731-2.

Wajon, A. and Ada, L. (2003) 'Prevalence of Thumb Pain in Physical Therapists Practicing Spinal Manipulative Therapy', *Journal of Hand Therapy*, 16(3), pp.237-244. https://doi.org/10.1016/s0894-1130(03)00039-5.