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Ergonomic risk assessment of Egyptian physical therapists

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ABSTRACT
Background: Physical therapists often perform physically demanding tasks such as patient handling, manual techniques, and prolonged awkward postures, which may lead to work-related musculoskeletal disorders (WMSDs).
Purpose: To evaluate ergonomic risk levels among Egyptian physical therapists, investigate the prevalence of WMSDs, and find out the correlation between these disorders and ergonomic risk.
Methodology: Seventy therapists (aged 25–36) from Al Qalyubia were assessed. RULA evaluated ergonomic risk during ultrasound and shoulder mobilization tasks, while the Cornell questionnaire identified WMSD prevalence.
Results: physical therapists are exposed to low to medium risk while applying the ultrasound and are exposed to medium to high risk while performing shoulder mobilization. The lower back, neck, and upper back were most affected, with a positive correlation to ergonomic risk.
Conclusion: Egyptian physical therapists are exposed to varying ergonomic risks depending on the task performed. WMSDs are common among Egyptian physical therapists and are positively associated with correlated with the ergonomic risk.

Keywords: *Ergonomics; Musculoskeletal disorders; Physical therapists; RULA.*

1. Introduction

"Musculoskeletal disorders" is a term that refers to a variety of preventable conditions that impact muscles, tendons, nerves, and supporting systems such intervertebral disks. Tendinitis, thoracic outlet syndrome, degenerative spine disease, carpal tunnel syndrome, and tension neck syndrome are a few of these conditions. Musculoskeletal disorders have a negative impact on workers' abilities, quality of life, and absence patterns[1].

The musculoskeletal system may be negatively impacted by increased occupational demands which can cause injuries or diseases known as work-related musculoskeletal disorders (WMSDs)[2]. Such disorders can result from repetitive micro-trauma or sudden trauma. Research shows that a number of factors may increase the chance of developing these disorders, including internal ones (such as age, weight, fitness, and malposture) and external factors (such as repeated movements, prolonged abnormal postures, repetitive direct pressure, and micro-trauma)[3].

Work-related musculoskeletal injuries have increased due to poor working conditions and a lack of techniques for preventing work-related injuries. It is the most frequent workplace injury in both developed and developing nations. The major cause of impairment among individuals during their working years and the most frequent self-reported work-related illness are musculoskeletal conditions. This is also in charge of medical expenses and earnings loss[4].

A systematic review shows that in the USA up to 90% of PTs experience WMSD at some point in their careers[5]. According to prevalence research by West and Gardner, up to 91% of PTs had work-related musculoskeletal disorders (WRMDs), with an 88% recurrence rate[6]. Also, a comprehensive study found that the lifetime prevalence of musculoskeletal pain among physical therapists ranged from 53 to 91%. The most often afflicted body part was the low back, which was followed by the neck, shoulders, upper back, and thumbs[7]. The prevalence of WMSDs in Egyptian PTs is 99.5%, with the neck (65.7%), shoulder (47.7%), wrist/hand (39.1%), upper back (37%), and lower

back (69.1%) being the most common anatomic regions. The two most frequent risk factors were treating obese patients and incorrect work posture[8].

According to studies Egyptian PTs suffer from a variety WMSDs affecting lower back as the most common affected area, neck, shoulders and upper back[8,2]. Working in awkward or stagnant positions, continuing to work through pain or injury and using poor body mechanics, were the most frequent therapist-related factors. Handling of heavier patients, lack of enough rest between cases was the working circumstances that Egyptian PTs reported as contributing factors[8]. Studies in other countries show that various tasks of PT job have different degrees of ergonomic risks varying from very high to low risks[9,10,11] and no similar studies were conducted in Egypt.

Investigating possible ergonomic risk factors in clinical physiotherapy might help develop early, targeted interventions to safeguard Physical therapists' musculoskeletal health, improve their job satisfaction, and eventually benefit patients. However, there is a lack of objective studies on the occupational tasks associated with physiotherapy[9]. Thus, the aim of this study was to evaluate and quantify the ergonomic risk among Egyptian physical therapists using the Rapid Upper Limb Assessment (RULA) scale (an objective, commonly used ergonomics risk scoring method) from the standpoint of motion analysis, to determine the prevalence of WMSDs and to find if there is correlation between the ergonomic risk and WMSDs.

2. Material and methods

2.1. Study design:

This study was a cross-sectional observational study.

2.2. Ethical considerations:

The study protocol was approved by the research ethical committee of faculty of physical therapy Cairo university (P.T.REC\012\005070). All subjects were asked to sign an informed consent form.

2.3. Subjects:

G-power analysis software was used with G*power software ver. 3.1.2 (Franz Faul, University of Kiel, Kiel, Germany). The sample size was calculated based on a power of 0.95 and an alpha level of 0.05. For measuring the correlation between two variables and effect size (r = 0.4), it was determined that 63 participants would be required. A target sample size of 63 participants was selected to ensure adequate power. Considering the 10% attrition, 70 PTs were recruited. The study was carried out on seventy of Egyptian (Al Qalyubia Governorate) adult physical therapists according to inclusion criteria in a period between June 2024 to November 2024. The study included subjects with age ranging from 25-36 years old, with at least one year of experience and both males and females were included. However, we excluded subjects with musculoskeletal diseases which may be like congenital or fracture or previous surgery, and pregnant females.

2.4. Instrumentation:

1) Rapid upper limb assessment (RULA):
   McAtamney and Corlett created the RULA technique in 1993. Its goal is to determine whether employees are exposed to upper extremity MSD risk factors while doing their jobs. The three elements that the approach evaluates are the muscular activity (repetitive motions or static posture), the load or force applied, and the posture of the various body parts12. Validity and reliability of the RULA had been investigated in previous researches13,14.
2) Cornell questionnaire:
   Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) is a self-reporting questionnaire to assess musculoskeletal disorders in neck, shoulders, thoracic, back, forearm, wrist, hand, thigh, buttocks, knee and foot. Dr. Alan Hedge of Cornell University, along with a team of ergonomics graduate students, developed the International Musculoskeletal Discomfort Questionnaire (MSD), which is now considered one of the most important questionnaires in the field of musculoskeletal disorders15. The validity and reliability of the Cornell had been investigated in previous researches16,15.

2.5. Measurement procedures:

1) Basic information was recorded including age, height & weight.
2) The subjects were screened for inclusion and exclusion, then the purpose of the study was explained to them, and they signed a consent form before the study began.

3) The physical therapists were given an explanation of RULA and how it evaluates postural load then the picture scored in the RULA sheet (final scores: 1or2: acceptable posture ,3or4: further investigations, changes may be needed,5 or 6 further investigations, changes soon, more than 7: investigate and implement changes).
4) Pictures were captured from both an anterior and lateral view to complete RULA and were analyzed by the researcher to find out the RULA scores.
5) The physical therapists discussed and completed the Cornell questionnaire to find out how prevalent musculoskeletal diseases were in the previous 12 months.
6) Coding the questionnaire for analysis and recoding it to prepare row data and make it suitable for statistical analysis.

2.6. Statistical analysis:

Descriptive statistics of mean, standard deviation, frequencies, percentages were utilized in presenting the subjects demographic and clinical data. Quantitative variables were summarized using mean and standard deviation while categorical variables were summarized using frequencies and percentage. The relationship between RULA score and Cornell Musculoskeletal Discomfort Questionnaire was investigated by Spearman's rank correlation coefficient. The level of significance for all statistical tests was set at $p < 0.05$. All statistical measures were performed through the statistical package for social studies (SPSS) version 25 for windows.

3.Results

The study included Seventy Egyptian physical therapists with a mean age of 30.27 ± 3.09 years (range: 25–36). The mean weight, height and BMI were 70.57 ± 13.58 kg, 166.73 ± 9.10 cm and 25.28 ± 3.79 kg/m² respectively. The sample comprised 49 females (70%) and 21 males (30%). Based on BMI classification, 54.29% of participants had normal weight, 31.43% were overweight, and 14.29% were obese. Subject characteristics presented in table 1.

Table 1. Participants' characteristics.

	Mean ± SD	Minimum	Maximum
Age (years)	30.27 ± 3.09	25	36
Weight (kg)	70.57 ± 13.58	48	106
Height (cm)	166.73 ± 9.10	153	194
BMI (kg/m²)	25.28 ± 3.79	19.05	35.60
	N	**%**	
Sex distribution			
Females	49	70	
Males	21	30	
Weight distribution			
Normal weight (18.5–24.9 kg/m²)	38	54.29	
Overweight (25.0–29.9 kg/m²)	22	31.43	
Obese (≥ 30 kg/m²)	10	14.29	

SD: Standard deviation

Ergonomic risk: RULA score in application of ultrasound on wrist and in shoulder mobilization:

The study assessed ergonomic risk using the Rapid Upper Limb Assessment (RULA) tool for two tasks: ultrasound application on the wrist and shoulder mobilization. The mean RULA score for ultrasound application was 3.94 ± 0.87 (range: 3–7), while for shoulder mobilization, it was higher at 6.01 ± 1.10 (range: 4–7).

In ultrasound application, most participants (81.43%) had a Level 2 risk (score: 3–4), with 17.14% at Level 3 (score: 5–6) and only 1.43% at Level 4 (score: 7). In contrast, shoulder mobilization posed a greater ergonomic risk, with 14.29% at Level 2, 40% at Level 3, and 45.71% at Level 4, indicating the need for immediate intervention to reduce musculoskeletal strain.

Table 2. RULA Scores for Ultrasound Application and Shoulder Mobilization Tasks:

	Mean ± SD		Minimum	Maximum
RULA score for ultrasound application on wrist	3.94 ± 0.87		3	7
RULA score for shoulder mobilization	6.01 ± 1.10		4	7
	RULA score for ultrasound application on wrist		**RULA score for shoulder mobilization**	
	Frequency		**Frequency**	
	N	**%**	**N**	**%**
Level 1 (score 1-2)	0	0%	0	0%
Level 2 (score 3-4)	57	81.43%	10	14.29%
Level 3 (score 5-6)	12	17.14%	28	40%
Level 4 (score 7)	1	1.43%	32	45.71%

SD: Standard deviation

Note: Level 1 = Acceptable posture, Level 2 = Further investigation, changes may be needed, Level 3 = further investigations, changes soon, Level 4 = investigate and implement changes.

Musculoskeletal disorders in neck, shoulders, thoracic, back, forearm, wrist, hand, thigh, buttocks, knee and foot: Cornell Musculoskeletal Discomfort Questionnaire (CMDQ):

The assessment of musculoskeletal disorder severity using CMDQ revealed varying levels of discomfort across different body regions. The highest mean severity scores were observed in the lower back (11.47 ± 13.20), neck (8.07 ± 10.06), and knees (right: 8.73 ± 17.90, left: 8.20 ± 20.33). The upper back (6.54 ± 14.54) and right shoulder (6.30 ± 16.61) also exhibited notable discomfort levels. In contrast, the lowest severity scores were recorded in the left forearm (0.89 ± 3.20) and hip (1.29 ± 2.78). These findings suggest that the lower back and knee regions may be the most affected. Table 3.

Lower back (82.86%) and neck (77.14%) showed the highest prevalence of discomfort, with most participants reporting moderate discomfort in the lower back (50%) and mild discomfort in the neck (42.86%).

Knees also had a notable prevalence (right knee: 57.14%, left knee: 45.71%), with moderate discomfort reported by around 27% for the right knee and 18.57% for the left knee.

Shoulders had moderate discomfort reported by 20% (right shoulder) and 18.57% (left shoulder), with slight discomfort affecting 17.14% and 15.71%, respectively.

Wrist discomfort was reported in 40% for the right wrist and 28.57% for the left wrist, with a moderate level being the most common.

Thighs and legs showed the least prevalence of discomfort, affecting 20 to 25% of participants, with mild discomfort being the most common.

Feet discomfort was similarly prevalent in both feet, affecting 30% of participants, with moderate discomfort most common.

Arms, forearms, hip, and feet exhibited lower levels of discomfort, with the forearms and hip showing the least frequency of discomfort. Table 4.

Table 3. Total score of CMDQ.

Severity of musculoskeletal disorders	Mean ± SD	Minimum	Maximum
Neck	8.07 ± 10.06	0	40
Right shoulder	6.30 ± 16.61	0	90
Left shoulder	4.66 ± 9.45	0	45
Upper back	6.54 ± 14.54	0	90
Lower back	11.47 ± 13.20	0	60
Right arm	3.84 ± 11.30	0	60
Left arm	2.69 ± 8.38	0	60
Right forearm	1.19 ± 3.33	0	20
Left arm forearm	0.89 ± 3.20	0	20
Right wrist	4.43 ± 11.05	0	60
Left wrist	1.69 ± 7.56	0	60
Hip	1.29 ± 2.78	0	14
Right thigh	1.41 ± 3.97	0	20
Left thigh	1.34 ± 3.42	0	20
Right knee	8.73 ± 17.90	0	90
Left knee	8.20 ± 20.33	0	90
Right leg	3.58 ± 12.33	0	90
Left leg	3.04 ± 12.13	0	90
Right foot	3.89 ± 13.20	0	90
Left foot	2.22 ± 5.12	0	21

SD: Standard deviation

Table 4. Prevalence of musculoskeletal disorders discomfort of different body regions.

	Frequency		
	1 (slightly uncomfortable)	**2 (moderately uncomfortable)**	**3 (very uncomfortable)**
Neck	31.43%	42.86%	2.86%
Right shoulder	17.14%	20%	4.29%
Left shoulder	15.71%	18.57%	4.29%
Upper back	38.57%	27.14%	2.86%
Lower back	27.14%	50%	5.71%
Right arm	14.29%	14.29%	1.43%

Left arm	14.29%	12.86%	1.43%
Right forearm	12.86%	7.14%	0%
Left forearm	10%	2.86%	0%
Right wrist	21.43%	17.14%	1.43%
Left wrist	14.29%	12.86%	1.43%
Hip	27.14%	7.14%	0%
Right thigh	8.57%	11.43%	0%
Left thigh	10%	10%	0%
Right knee	20%	27.14%	10%
Left knee	17.14%	18.57%	10%
Right leg	8.57%	12.86%	4.29%
Left leg	8.57%	10%	2.86%
Right foot	11.43%	15.71%	2.86%
Left foot	14.29%	14.29%	1.43%

Correlation between RULA score in application of ultrasound on wrist and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ):
There was a weak positive significant correlation between the RULA score in the application of ultrasound on the wrist and total score of CMDQ of the right arm ($r = 0.262$, $p = 0.02$). There was a weak positive significant correlation between the RULA score in the application of ultrasound on the wrist and total score of CMDQ of the left leg ($r = 0.251$, $p = 0.03$). Other body regions show non-significant correlations. Table 5.

Correlation between RULA score in shoulder mobilization and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ):
There was a weak positive significant correlation between the RULA score in shoulder mobilization and total score of CMDQ of the right shoulder ($r = 0.236$, $p = 0.04$), right forearm ($r = 0.270$, $p = 0.02$), left forearm ($r = 0.244$, $p = 0.04$), right knee ($r = 0.251$, $p = 0.03$), the right leg ($r = 0.291$, $p = 0.01$) and left leg ($r = 0.266$, $p = 0.02$). There was a moderate positive significant correlation between the RULA score in shoulder mobilization and total score of CMDQ of the right wrist ($r = 0.322$, $p = 0.007$). Other body regions show non-significant correlations. Table 5.

Table 5. Correlation between RULA score and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ):

	RULA score in application of ultrasound on wrist		**RULA score in shoulder mobilization**	
Severity of musculoskeletal disorders	**r value**	**p value**	**r value**	**p value**
Neck	-0.059	0.629	0.072	0.552
Right shoulder	0.228	0.057	0.236*	0.04
Left shoulder	0.093	0.445	0.019	0.876
Upper back	0.099	0.415	-0.199	0.098
Lower back	-0.064	0.598	0.222	0.065
Right arm	0.262*	0.02	0.189	0.118

Left arm	0.115	0.345	0.065	0.593
Right forearm	0.207	0.085	0.270*	0.02
Left arm forearm	0.119	0.326	0.244*	0.04
Right wrist	-0.086	0.480	0.322**	0.007
Left wrist	-0.154	0.202	0.167	0.167
Hip	0.068	0.577	-0.139	0.252
Right thigh	-0.058	0.635	0.082	0.499
Left thigh	-0.061	0.614	-0.166	0.170
Right knee	0.099	0.415	0.251*	0.03
Left knee	0.032	0.795	-0.054	0.656
Right leg	0.213	0.076	0.291*	0.01
Left leg	0.251*	0.03	0.266*	0.02
Right foot	0.072	0.555	0.213	0.076
Left foot	0.040	0.740	0.162	0.181

RULA score in shoulder mobilization; p value: Probability value; * P < 0.05

4.Discussion

This study assessed the prevalence of work-related musculoskeletal disorders (WMSDs) among Egyptian physical therapists and examined the correlation between ergonomic risk and these disorders. Seventy participants from both genders were evaluated using the RULA method for ergonomic risk and the Cornell questionnaire for musculoskeletal symptoms.

Results indicate that performing ultrasound therapy on the wrist poses a low to medium ergonomic risk, with 81.43% of participants at level 2 (scores 3–4), suggesting that improvements are necessary but not urgent, and 17.14% at level 3 (scores 5–6), requiring short-term changes. In contrast, performing shoulder mobilization (inferior glide) involves higher ergonomic risk: 40% are at level 3 and 45.71% at level 4 (score 7), necessitating urgent intervention. A high prevalence of WMSDs is reported, particularly in the lower back (82.86%), neck (77.14%), and upper back (68.57%), followed by the knees, shoulders, and wrists. These issues are likely due to repetitive movements, awkward postures, and the physical demands of patient care. Significant positive correlations are found between RULA scores and CMDQ scores for various body regions in both tasks, indicating that poor ergonomic postures directly contribute to musculoskeletal discomfort.

In alignment with prior Egyptian studies, these results are supported by a study, which identified similar top-affected regions, and highlighted uncomfortable postures and heavy patient handling as major risk factors[8]. Similarly, other studies reported lower back pain as the most prevalent complaint[17], and found that over 83% of physiotherapists experienced WMSDs in the upper and lower back[2]. On a broader scale, our findings align with international literature. A study concluded that the lower back is most commonly affected globally, followed by the neck, shoulders, and wrists[5]. However, another study reported the wrists and hands as most frequently affected[18], possibly due to variations in study design and population.

There is a knowledge gap regarding ergonomic risk in ultrasound application within physiotherapy. Comparable data from sonographers show similar risk scores (RULA 3.11–5.00), with high rates of discomfort in the shoulders, lower back, and wrists[19], aligning with our findings. For shoulder mobilization (inferior glide), similar tasks such as shoulder mobilization dorsal glide also present medium ergonomic risk[10]. Further research is recommended to evaluate specific techniques in physiotherapy.

Literature emphasizes contributing factors such as patient lifting, static postures, repetitive movements, and poor scheduling[6]. Preventive strategies include proper alignment during treatment, sufficient rest breaks, and maintaining physical fitness. Exercises and a healthy lifestyle may enhance muscular endurance and reduce injury risk[20].

5.Conclusion:

According to the findings of the study, it can be concluded that the most prevalent musculoskeletal disorder among Egyptian physical therapists is in lower back followed by neck then upper back. Also, knees, shoulders and wrists musculoskeletal disorders have high incidence among physical therapists. Additionally, there is positive correlation between high ergonomic risk while performing Task 1 (ultrasound on the wrist) and increased musculoskeletal disorder of the right arm and the left leg and a positive correlation between high ergonomic risk while performing Task 2 (shoulder mobilization-inferior glide) and increased musculoskeletal disorder of the right shoulder, right forearm, left forearm, right knee, right leg and left leg. Therefore, we should focus on improving physical therapists' ergonomic awareness of their body posture while working and provide them with ergonomically designed equipment to facilitate their job with the least possible harm. Also, focus on ergonomics education in the undergraduate years of study.

6.Disclosure

Limitation: This had some limitations. First, the prevalent part of the study relied on self-reported data (CMDQ) which could introduce recall bias or inaccurate reporting. Second, limited task range (only two tasks were studied). Third, larger sample size is needed for more generalization.

The following recommendations are suggested:

1) A similar study can be conducted on a larger sample size to confirm and provide more generalization of the results.
2) A similar study can be conducted on different age groups and compare between different age groups.
3) Other studies to assess the ergonomic risk of other physical therapy tasks.
4) Apply ergonomic measures to prevent musculoskeletal disorders.
5) Physical therapy faculties should focus on training educating ergonomics with more depth and focus on the mechanics and wellbeing of physical therapists.

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