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Prevalence of work-related musculoskeletal pain among programmers and the associated ergonomic risk factors: Cross-sectional and case studies

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Abstract

Background: Ergonomics is the adaptation of the work and workplace to the worker by designing tasks within the workers, capabilities and limitations to increase worker efficiency and decrease injuries.

Objective: This study aimed to determine the prevalence of work-related musculoskeletal pain (WMSP) by region in programmers. As well, this study presented a case with WMSP and the associated factors.

Methods: A survey was posted on a large Facebook group of programmers (Million Egyptian programmers) containing questions about presence of pain and the region. The prevalence of pain was calculated by region. Then, a case with pain was described including clinical assessment and the associated risk factors.

Results: 378 programmers responded to the survey; out of them, 232 programmers had neck pain (61.4%).

Conclusion: WMSP is prevalent among programmers especially neck pain. There are several risk factors that might be associated with this pain including poor posture, poor workstation setup, and poor movement technique. Several solutions to these risks were provided and recommended by the authors.

Keywords: Programming; human factors, risk, WMSDs.

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Introduction:

A programmer is a professional who writes, tests, debugs, and maintains the detailed instructions (known as code) that computers follow to perform tasks. These tasks can range from simple commands to complex systems and applications. Programmers work in a variety of settings including corporate IT departments, software companies, government agencies, and as freelancers. The job often requires long periods of sitting and computer use.

These demands lead to high liability to work-related musculoskeletal disorders (WMSDs) in programmers. Survey studies reported that up to 73% of programmers had neck pain, 55.8% had shoulder pain, 37.4% had upper back pain, 94% had low back pain, 58% had elbow pain, and 4% knee and thigh pain.[1-10]

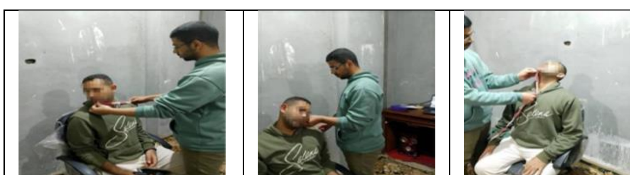
Programmers are particularly susceptible to developing WMSDs due to the nature of their work and work environment. Programmers spend several hours daily sitting in front of screens causing muscle imbalances, impaired circulation, and increased spinal loadings.[11] They also do repeated motions such as clicking and typing causing strain muscles and tendons.[12] This is exacerbated by sustaining awkward postures such as hunching stressing on the musculoskeletal system and leading to discomfort, stiffness, and fatigue.[13] This is further exacerbated by poor setup of the environment and workstation of the programmers with inadequate lighting, improperly positioned monitors, and non-adjustable chairs.[14] Programming can be mentally demanding and stressful increasing muscle tension and WMSDs.[15] The lack of regular physical activity encountered by programmers due to nature of their work causes muscle weakness and inflexibility.[16] Finally, inadequate breaks to rest and stretch encountered by programmers cause muscle fatigue increasing the MSDs risk.[17] As a consequence, programmers frequently document several common complaints during their work sessions in form of neck, shoulder, back, and wrist and hand pain and eye strain.

In addition to that, a previous study[18] reported that there is lack of evidence about the effect of prolonged sitting in programmers. Therefore, this study aimed to determine the prevalence of work-related musculoskeletal pain in programmers and the associated risk factors. It also recommended an ergonomic program to reduce these risks.

Methods:
Phase 1:
Study setting and design:
In this phase, a cross-sectional study was applied. It was conducted ONLINE (Facebook) on 3/2024.
Participants:
All programmers presented on the Facebook group of programmers (Million Egyptian programmers) at the day of the study survey who counted 946974 Egyptian programmers.
Procedure:
A survey questionnaire (**https://www.facebook.com/share/p/RRZjszxo3BiZeV48/?mibextid=xfxF2i**) was posted on a Facebook group of programmers (Million Egyptian programmers). It included simple questions in Arabic about the presence and site of pain (these questions were reviewed by the authors for its relevance/clarity. Prevalence of pain by region was calculated.

Phase 2:
Study setting and design:
In this phase, a case study was conducted in which a programmer with neck pain was assessed at home on 3/2024.
Participant:
The participant was 25-Year-Old male Software Engineer at Qalubiaya – Egypt. He had discogenic lumbar pain for 1year.
Procedure:
Consent form was taken from the participant before starting assessment and he signed it. Then, the participant was assessed at three time intervals, at baseline, after 1 week, and then after 2 weeks.
The following were variables assessed;
Risk Factors: ART tool was used to assess the risk factors associated with the pain (neck, shoulder, and back pain) presented in this programmer.[19] It assesses tasks that require repetitive moving of the upper limbs (arms and hands). It assesses some of the common risk factors in repetitive work that contribute to the development of upper limb disorders (ULDs). It can help identify those tasks that involve significant risks and where to focus risk-reduction measures. It includes an assessment guide, a flow chart, a task description form and a score sheet. A score > 22 means high risk and that the worker needs further investigation which is required urgently.
Pain severity: Neck, shoulder, and Back Pain and eye Pain were assessed using visual analogue scale (VAS).[20] It is reliable and valid scale for pain measurement.[21]
Postural Assessment: Camera was used in this study to take pictures and videos during awkward posture and working for observational analysis of body posture with help of Kinovea software.[22]
Cervical mobility: Tape measurement was used to assess the range of motion (ROM) of the neck (flexion, extension, side bending and rotation). It is found to be valid and reliable for measuring mobility.[23]

Procedures for assessing ROM using tape measurement were shown in figure (1).



A) Rotation (Right)	**B) Side-bending (Left)**	**C) Extension**

Fig. (1): Cervical ROM measurement using tape.

Results:
Phase 1:
Among the 946974 Egyptian programmers presented on the Facebook group of Million Egyptian programmers, there were 378 responders. Out of them, there were 339 programmers had neck pain (61.4%) as shown in figure 2.

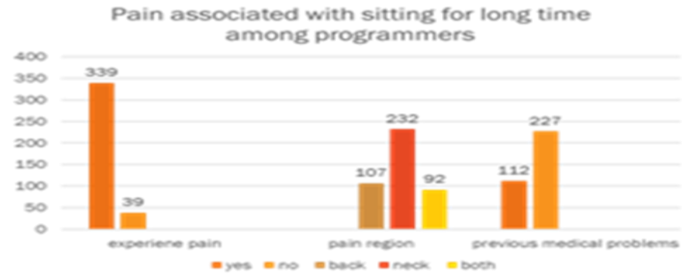


Fig. (2): Prevalence of pain as a whole and categorized by region

Phase 2:

Risk factors:

Art tools showed that the participated programmer had a high risk (≥37.5) for work-related musculoskeletal disorders (WMSDs) as shown in table 1.

Table (1): Results of ART tool.

Risk Factors	Left Arm		Right Arm	
	Color	Score	Color	Score
A1 Arm Movements		0		0
A2 Repetition		3		3
B Force		4		8
C1 Head/Neck Posture		2		2
C2 Back Posture		1		1
C3 Arm Posture		2		2
C4 Wrist Posture		2		2
C5 Hand/Finger Grip		0		0
D1 Breaks		8		8
D2 Work Pace		1		2
D3 Other Factors		2		2
Task Score		25		30
D4 Duration Multiplier		X1.5		X1.5
Exposure Score		37.5		45
D5 Psychosocial Factors 1. Stress and confusion about the deadlines and anxiety. 2. High level of concentration and attention. 3. Excessive work demands				

Pain severity:

VAS showed that this worker had moderate pain (between 4 and 6) in his neck, back, shoulders, hands, and wrists. The pain was higher (6) in neck and wrists as shown in figure 3.

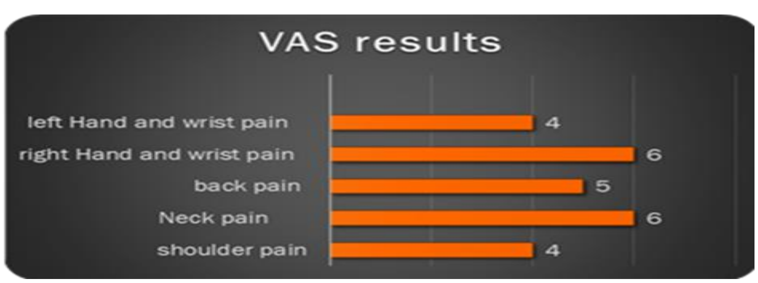


Fig. (3): Results of VAS by region.

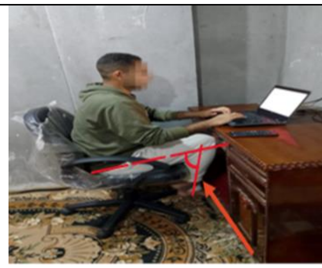
Postural Assessment:

By analysis of the pictures and videos using Kinovea and by observation, there were postural faults with abnormal angles (putting the joints in ROM that is out of ergonomic range) as shown in table 2 and figure 4.

Table (2): Results of assessment of worker posture and workplace design

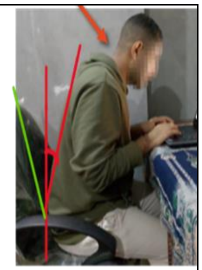
Variable	Measurement
The Angle Between Display Screen And The Light	34 degrees
The Distance Between Display And Disk	21cm
The Angle Between Forearm And Arm (Elbow Angle)	180 degrees
The Height Of The Table	80 cm
The Height Of The Chair	42 cm
Angle Between Thigh And The Leg (Knee Angle)	67 degrees
The Trunk Angulation	18 degree forward
The Width of Screen	38 cm
The Length of Screen	24cm
Observing cervical, thoracic, and lumbar region during work revealed	Neck side bending to hold phone during work Thoracic hyper-kyphosis Lumbar hypo-lordosis

A) Elbow angle



B) Knee angle

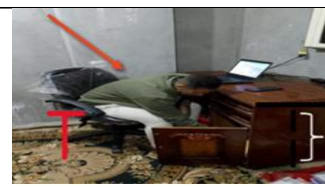
C) Neck position (Side-bending)



D) Trunk forward inclination and neck flexion

E) angle of light on screen

F) Screen width and height



G) Chair and table height and trunk bending

Fig. (4): Showing postural faults taken by the programmer during the work that were associated with poor workplace design.

Cervical mobility:

Tape and goniometers measurements revealed that the programmer had limited cervical mobility especially left side-bending and right rotation as shown in table 3.

Table (3): Cervical mobility assessment using tape measurement

Motion	ROM (cm)
Flexion	11cm
Hyper Extension	22 cm
Right Side Bending	8 cm
Left Side Bending	7 cm
Rotation To The Right	8.5 cm
Rotation To The Left	10 cm

Discussion

This study aimed to determine the prevalence of WMSP among programmers. As well, this study reported a case with WMSP identifying the characteristics and the risk factors associated with this pain. This study found high prevalence of WMSP among programmers especially neck pain which affected about 61.4% of them. In addition, this study reported that the programmer had high risk for WMSDs that may be due to the documented postural faults and poor joint positions regarding ergonomics with poor workplace design.

The programmer had moderate pain in his spine and upper body which may be explained by uninterrupted work hours exceeding 12 hours putting excessive strain in his neck and shoulders. Additionally, prolonged sitting exacerbates low back fatigue and hand pain. Several contributing factors compound these issues, including improper desk height, suboptimal lifting techniques, incorrect display and chair heights, and inadequate hand rest pad.

To address these concerns, the researchers recommend implementing ergonomic interventions both for the individual and the workplace. For the programmer, increasing awareness of proper posture while standing and sitting, adjusting display settings, and adopting safe lifting techniques are advised. While, at the workplace level, attention should be given to floor covering, storage solutions, adjustable chair, and table height to promote ergonomic comfort and safety. This program was described in detail in APPENDIX I and figure 6.[24-26]

Magalhães and Rodrigues (2025)[27] found that ergonomic interventions (screen dsin, postural adjustments) significantly improved upper back and neck musculoskeletal symptoms at the end of workdays. Findings suggest that an ergonomic intervention program can benefit employees by reducing visual and musculoskeletal symptoms.

The program and recommendations of the current study aimed to enable the programmer to work comfortably and efficiently, emphasizing the importance of ergonomics in optimizing performance and preventing work-related discomfort and injuries.

Limitations:

This study is limited by some but not all of the factors affecting programmers and their complaints, other factors as psychosocial status may be present. In addition, sample size is too small and no variety in age or gender which doesn't properly represent the whole population.

Conclusion:

This study showed high prevalence of WMSP among programmers reaching up to 61.4%. In addition, it found that programmers are vulnerable to high-risk ergonomic factors as poor posture and poor workplace design which may be the cause behind the complaint of neck, low back, shoulder and hand pain in the programmer. Authors suggested recommendations to promote awareness among programmers to solve these issues (APPENDIX I and figure 6).

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APPENDIX I
Recommendations by the authors to reduce high risk for WMSDs among programmers

Advices to the programmers[24-26]	Advices for improving workplace design[24-26]
Correct Posture: sit upright with your back supported by the chair, keep your shoulders relaxed and elbows close to your body, and avoid crossing your legs or sitting in awkward positions	Proper desk and chair setup: adjust the height of the desk so that your elbows are bent at a 90-degree angle over the keyboard, make sure your feet are flat on the ground and your knees are bent at a 90-degree angle with good lumbar support in your chair and when working from a standing position, the table height should be around five centimeters above elbow height for precision work and proper elbow support.
Use Ergonomic Accessories: consider using ergonomic accessories such as a monitor stand, adjustable chair, or keyboard tray to improve comfort and support.	**Monitor Positioning:** position the top of the monitor at or slightly below eye level and place the monitor at arm's length away.
Regular breaks and movement: take short breaks every hour to stretch and move around and follow the 20-20-20 rule; every 20 minutes, look at something 20 feet away for at least 20 seconds.	**Keyboard and mouse placement:** keep the keyboard and mouse at the same height and use a wrist rest or cushion to support your wrists while typing or using the mouse
	Proper lighting: position your workstation to minimize glare on the screen (light should not go directly or indirectly to eyes) and ensure adequate lighting.

A) Proper neck position while telephoning	B) Proper sitting position and workstation design	C) Proper reaching and movement ergonomics

Fig. (6): Recommendations for reducing high risk for WMSDs in programmers