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Original Article

Patterns and root causes of exposure to ergonomics risk factors among Malaysian office workers: retrospective study from practitioners' reports

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ABSTRACT

Introduction: Symptoms of musculoskeletal disorders are common among office workers worldwide. However, there has been limited published data that examine patterns and root causes of exposures to ergonomics risk factors, especially sourced from ergonomists' assessment reports. This study investigates the prevalence rates of Musculoskeletal Disorder (MSD) symptoms, ergonomics risk factor exposure patterns, and root causes of these exposures among office workers in Malaysia ergonomists' perspectives.

Methods: A retrospective study was conducted among Malaysian office workers. Data were extracted from 399 individual ergonomics assessment reports prepared by professional ergonomists. These reports were obtained over a period of 17 years (March 2001 until November 2018), across 16 different offices in 5 states and 1 Federal territory. In addition to self-report body symptom data, extracted data includes ergonomics risk factors, and root causes identified by professional ergonomists. Descriptive and statistical analyses were conducted to determine patterns from extracted data.

Results: Data showed high MSD symptoms prevalence (87%) of varying degrees among sample population. The body parts most affected among sample population include shoulder (42%), lower back (38%) and neck (32%). Gender and age are seen to be associated with the reported MSD symptoms severity levels. Common ergonomics risk factors among office workers include poor posture (97%), static loading (90%), and contact stress (74%). The majority of the root causes to individual's ergonomics exposures can be traced to substandard workstation setups as well as poor work habits.

Conclusion: The study provides insight on patterns and root causes of exposure to ergonomics risk factors among Malaysian office workers from ergonomists' point of view.

Keywords: Ergonomics risk factors; Musculoskeletal disorder symptoms; Office ergonomics; Prevalence.

Introduction

The number of work-related musculoskeletal disorders and ergonomics compensation cases in Malaysia has been rising steadily compared to other occupational diseases. Statistics from Malaysia's Social Security Organisation (SOCSO) in 2020 showed that for every four occupational disease cases reported to SOCSO, one was related to musculoskeletal disorders.[1] There have been similar trends reported on high prevalence of musculoskeletal disorders in other developing

economies. [2-6]

Multiple studies have been carried out by researchers to determine the prevalence of musculoskeletal disorder symptoms among office workers in developing countries. [7-13] However, previous ergonomics studies by these researchers were conducted primarily through cross-sectional studies, in which study participants provided self-report data to the researchers. There have been limited published studies focusing on summarization of ergonomics assessment results conducted by ergonomics practitioners or professional ergonomists. Specifically, analyses on root causes of ergonomics risk factors exposures in Malaysian office settings have not been well documented.

This study investigates ergonomics-related issues among Malaysian office workers, from perspectives of local professional ergonomists. It is intended to summarize the prevalence trend of musculoskeletal disorder symptoms among study population. In addition, the study also aims to identify ergonomics risk factors' exposure patterns and analyze the root causes to these exposures. The findings on high prevalence of MSD symptoms, identification of specific ergonomics risk factors, and root causes of substandard workstation setup and poor work habits provide some degree of insights on specific ergonomics issues in Malaysian office settings, which in some degree may also benefit researchers and practitioners facing similar issues in other developing countries.

Methods

Ergonomics assessment reports were obtained from a local ergonomics consulting service provider for industrial clients. The report was prepared by professional ergonomists with at least ten years of experience and fulfilled all criteria as an ergonomist set by the Department of Occupational Safety and Health, an agency under Ministry of Human Resources. A total of 419 ergonomics assessment reports from multiple site visits between March 2001 and November 2018, across 16 different offices in Malaysia were retrieved. The reports were screened for contents, of which 20 reports were excluded as these were MSD diagnosed cases involving permanent disability. The screening results in a selection of 399 reports for further analysis.

Data from the reports were extracted and analyzed through multiple stages. The first stage involved extracting workers' demographic information. The data included but not limited to workers' gender, age, and type of industries. The second stage looked into obtaining MSD symptoms data from each individual report. During assessment, each office worker was given a self-report instrument to document MSD symptoms on body parts, as well as the severity levels in the past 12 months. This allowed the ergonomists to categorize the MSD symptom data into four severity levels: 1) Level 0: workers who do not have any discomfort or pain, 2) Level 1: workers who have occasional pain and discomfort but subsides after resting, 3) Level 2: workers who reported frequent discomfort or pain but subsides within 3 months, and 4) Level 3: workers reported persistent discomfort or pain beyond 3 months (chronic). The categorization of MSD symptom levels was adapted from documents by a government-linked agency and a not-for-profit organization.[14-15] The third stage extracted individual work exposures from each report, including work postures, workplace setups, and tasks in their respective office setups. In addition, data extraction includes ergonomists' documentation of ergonomics risk factors and their analysis on the root causes of exposure.

Descriptive statistical analysis was conducted to analyze data trends on population's demographic, MSD symptom prevalence, and body parts affected. IBM SPSS Statistics (v23) was used for relevant statistical analysis. A chi-square test was used for the categorical (gender) and continuous variables (age group) to determine their association to MSD symptom levels. The level of statistical significance was set at $P \leqslant 0.050$. Phi and Cramer's V test were then used to measure the strength of statistical relationship between two tested variables. Exposure to ergonomics risk factors was analyzed through descriptive statistics, and root causes were obtained from ergonomists'

analysis descriptions.

Results

The sample population consisted of 399 office workers working in 16 different office premises, from various organizations including manufacturing, communications, services, oil & gas and construction sectors within 5 states (Selangor, Negeri Sembilan, Melaka, Johor, and Sabah) and a Federal Territory (Kuala Lumpur) in Malaysia. Study population was comprised of both genders, varying age groups, and covering different office type jobs or positions. The demographic data is presented in Table 1.

Table 1: Demographic data of workers (n=399).

Characteristics	Number of populations (Percentage %)
Gender	
Male	171 (43)
Female	228 (57)
Age group	
20-29	73 (18)
30-39	115 (29)
40-49	60 (15)
50-59	57 (14)
60 and above	4 (1)
NA	90 (23)
Type of job / position	
Top Management	12 (3)
Managerial	46 (12)
Executive	14 (4)
Clerical	33 (8)
Engineer	52 (13)
Analyst	67 (17)
Advisor	25 (6)
Coordinator	13 (3)
Accountant	7 (2)
Scientist	18 (5)
Controller	7 (2)
Supervisor	9 (2)
Technologist	13 (3)
Others (Designer, Specialist, Researcher, Operator and Inspector)	83 (20)

1. Prevalence of Musculoskeletal Symptom Levels among study population

Overall, 87% of the study population (n=399) reported a certain degree of MSD symptoms. Specifically, 27% of workers were categorized as level 3 (chronic persistent pain), 35% were at level 2 (frequent discomfort & pain), and 25% at level 1 (occasional discomfort & pain). This indicates only a small percentage of the study population (13%) were healthy with no reported discomfort or pain symptoms. The processed data indicates that higher percentage of female population (89% [202/228] of female workers) reported MSDs symptoms compared to male (78% [134/171] of male workers). Chi-square test on sample data revealed that gender is significantly associated with MSD symptom severity level. In addition, Phi and Cramer's V test showed borderline moderate-strong association (φ =0.30) between gender and MSD symptom levels. Findings showed that the 30 to 40 years old age group contributed to the highest percentage of reported

MSD symptoms (34% of the study population) compared to other age groups (Figure 1). It was found that across all age groups, approximately 3-4 % of the study population did not report any pain and discomfort symptoms. In the 21-30 years old age group, more than one-third of workers (~40%) were categorized as having Level 1 MSD symptoms, followed by those in Level 2 (~30% of workers). Meanwhile, in the 31-40 years old age group, close to half of workers (~47%) were categorized as having Level 2 MSD symptoms, followed by those in Level 3 (~29% of workers). In the 41-50 years old age group, no obvious trend of prevalence was observed across these three MSD symptom levels. In the above 50 years old age group, more than one-third of workers (35%) were categorized as Level 3, followed by those in Level 2 (~30% of workers). The chi-square test showed that age groups have a significant association with MSD symptom levels ($p < .05$). Phi and Cramer's V test showed a moderate statistical association between these two variables ($\varphi = 0.19$).

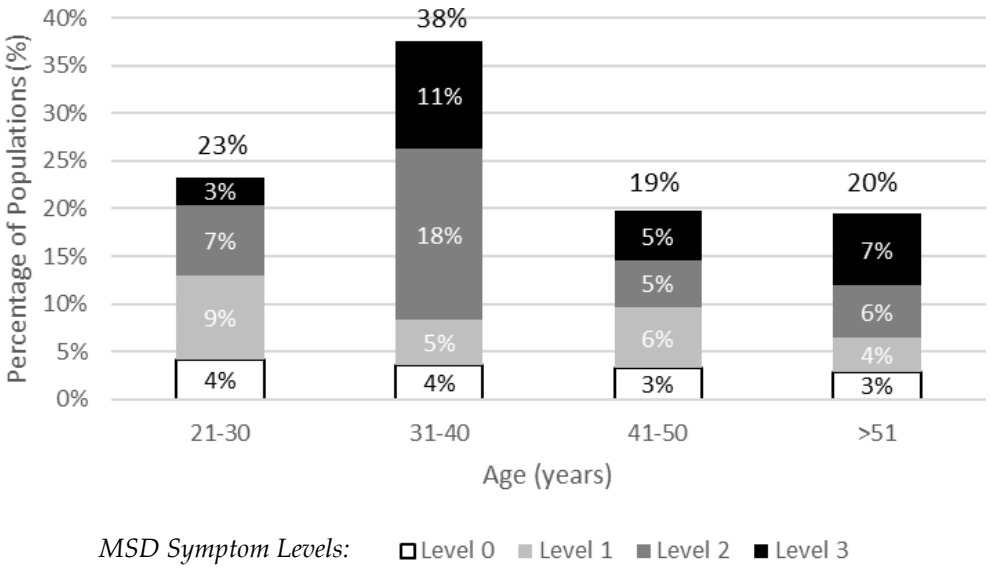

Figure 1: Percentage of MSD Symptom levels by age groups.

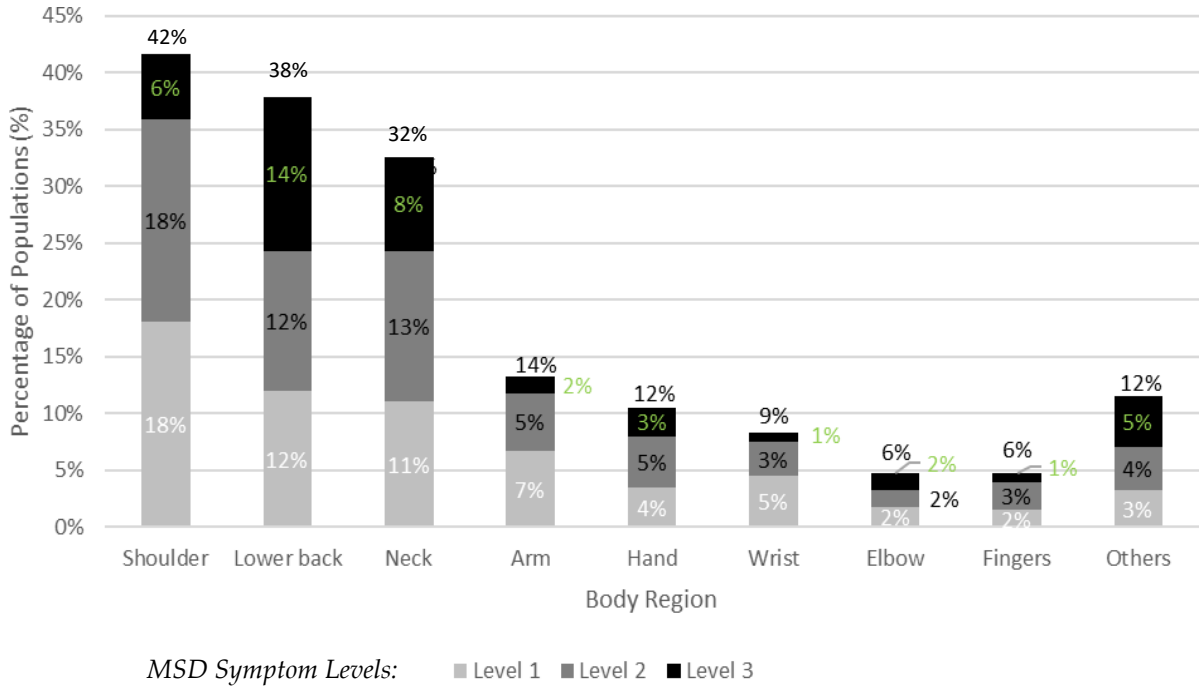

Figure 2: Prevalence rate of pain and discomfort by body region.

In general, a large portion of the study population (42%) reported experiencing some degree of pain and discomfort on the shoulders. In addition, 38% and 32% of the study population reported pain and discomfort on lower back and neck, respectively. Discomfort and pain on other body parts such as arm, hand, wrist, elbow, finger and other body parts were reported among 6 – 14% of study population. In terms of severity level of the workers' MSD symptoms by body parts, there was similar trend observed, in which MSD symptoms of Level 1 and 2 made up plurality of the reported cases. The exception was on low back, where Level 3 MSD symptoms made up more than one third of low back cases. The prevalence data is illustrated in Figure 2.

Table 2: Percentage and frequency of office workers exposed to ergonomic risk factors by body parts.

Ergonomic Risk Factors	Body parts affected	Frequency (Percentage %)
Poor posture	Shoulders	249 (62)
	Elbows	241 (60)
	Neck	197 (49)
	Upper back	140 (35)
	Lower back	136 (34)
	Arms	59 (15)
	Hands	48 (12)
	Fingers	29 (7)
	Legs	15 (4)
	Feet	11 (3)
	Wrists	10 (3)
	None	10 (3)
Static loading	Shoulder	293 (73)
	Neck	289 (72)
	Arm	247 (62)
	Lower back	151 (38)
	Upper back	103 (26)
	Hands	52 (13)
	Elbows	13 (3)
	Legs	13 (3)
	Fingers	12 (3)
	Wrists	2 (~1)
	None	39 (10)
Contact stress	Forearms	197 (49)
	Wrists	65 (16)
	Hands	24 (6)
	Elbows	8 (2)
	Hand Palms	5 (~1)
	Feet	4 (~1)
	Hips	2 (~1)
	Leg	2 (~1)
	None	103 (26)

Note: Ergonomists may identify more than one ergonomics risk factors and affected body parts in each individual worker's assessment.

2. Ergonomics Risk Factors and Root Causes

Overall, several ergonomics risk factors were identified by ergonomists in their assessment reports. The risk factors include poor posture, static loading, contact stress, repetitive motion and forceful exertion, which are established contributors to the development of work-related MSDs. [16] The analysis from reports indicated that 97% of office workers were found to adopt poor posture affecting at least one body part when using computers. The majority of office workers were exposed to poor posture on the shoulder, upper arm and neck region. A high percentage of workers (60%) were exposed to poor posture related to shoulder. Poor workstation set-up as well as the work habits of office workers were observed to be among the root causes associated with poor shoulder posture. Root causes related to workstations can mostly be traced due to either 1) high fixed work surface height, or 2) chair height was set too low. In addition, it was found that workers adopted poor upper extremity postures due to mouse and keyboard placements. Mouse and keyboard were set above elbow height and placed further on the work surface requiring overextending of arms. Besides, poor placement of display monitors and referred documents (not directly in front of body midline) was found to be the root cause for adopting poor neck posture, as workers were observed to repetitively twist the neck during data key-in or general typing activities.

The study found that most of the sample population (90%) were exposed to static postures affecting at least one body part throughout their work shift. Analysis by body parts revealed that around 73%, 72% and 62% of the study population were exposed to static loading on shoulder, neck, and arm, respectively. The minimal movements were likely due to poor work habits and a lack of awareness by office workers to embed micro-movements and stretching activities into their work schedule. In addition, the majority of workers (77%) were only provided with non-height-adjustable computer workstations. There were several cases where the highest chair adjustment did not allow neutral shoulder and arm postures, due to the fixed height of the work surface. As such, these workers had to adopt prolonged raised shoulders or poor arm posture at their individual workstations.

The majority of office workers (74%) were exposed to contact stress affecting at least one body part. Contact stress on forearms represented the largest group (49%), followed by wrist region (16%). Other body parts exposed to contact stress included hand, elbow, palm, and lower extremities. The primary root cause of contact stress is the solid sharp edge of fixed-height work surface, in combination with inadequate chair height setup. Contact stress on the upper extremities such as forearm, wrist, and elbow depends on where the keyboard and mouse are located, as this will determine the contact point between work surface edge and soft tissues of the office workers. Contact stress on hips and lower limbs were due to improper chair size and direct contact with items stored underneath work surface such as pedestal or boxes.

In addition to poor posture, static posture, and contact stress, office workers were also observed to be exposed to repetitive motion and forceful exertion. One of the most common repetitive exposures by office workers (21%) was observed in the neck region due to upward and downward neck motion when alternately looking between monitors and keyboards. Some workers adopted frequent neck twisting to the left when referring to hard copy documents. A small number of office workers were exposed to forceful exertion during typing either because of their poor work habits or using older keyboard models with high force to operate key buttons. In addition, some workers adopted claw grip techniques when gripping the mouse which can lead to biomechanical strain on the wrist area. Ergonomic risk factors exposure by body parts is summarized in Table 2. Examples of identified ergonomics risk factors and their root causes are summarized in Figure 3.

Workers adopting raised shoulder due to inappropriate chair-desk height setup in combination with poor work habit.

Workers adopting poor extended arm posture due to poor placement of keyboard and mouse.

Worker adopting frequent poor neck posture due to insufficient accessory (document holder) to support data entry task (left). Worker adopting static poor neck posture due to poor placement of primary monitor (right).

Workers are exposed to contact stress on forearms due to inappropriate chair-desk height setup in combination with desk's solid sharp edge.

Figure 3: Examples of identified ergonomics risk factors and root causes from ergonomists' reports.

Discussion

This study found a high prevalence of MSD symptoms among study population which agrees with other prevalence studies in Malaysia and other countries. [10-12,17-18] This reconfirms the trend of high prevalence among office workers. It is concerning that the data showed similar trends to other studies conducted years ago. [19-21] This suggests limited or ineffective efforts and improvement actions have been taken to overcome the issue, despite multiple similar data showing the same trending patterns over the years.

This study showed a significant association between gender and MSD symptoms. This supports the findings of several cross-sectional studies conducted among office workers from developing economies such as Malaysia, Turkey, Taiwan, Iran, and Korea which found a strong relationship between gender and MSD symptoms.[22-26] Office furniture may not fully accommodate the body dimensions of smaller Asian populations, and the effect may be more significant among female workers. A study conducted among 142 full time office workers in Thailand found that the majority of female office

workers had inappropriate workstation height which is above their elbow height.[27] Another study on female Hong Kong office workers reported that office chair being used are generally oversized.[28] The authors argued that office chairs designed by and for Western population may have mismatches to Asian women in terms of design compatibility with anthropometrical dimensions.

Findings showed that a significant relationship has been found between age and MSD symptoms. Particularly, it was observed that office workers below 40 years old are more likely to report MSD symptoms compared to office workers above 40 years old. This result is supported by the finding of a cross-sectional study among health workers which found that more than half of the workers reported two or more complaints in different musculoskeletal regions and these problems had appeared before the age of 40.[29] The reason for this trend might be due to the likelihood of office workers being promoted to managerial level at older age. The demand for computer usage is likely to decrease for older office workers, as they may be spending more time on meetings or other decision-making activities rather than spending most of the working hours in front of the computer. Another explanation that may explain this trend is the survivor effect, in which the office workers who have MSD symptoms at younger age may have switched to a different job as a way to manage their symptoms. Hence, these reasons may explain the higher prevalence of MSD symptoms among 20-40 years old workers.

Musculoskeletal discomfort complaints among office workers were mostly reported in the shoulder, lower back and neck regions. The results are in line with few studies conducted among office workers from developing economies including Iran, Turkey and Taiwan which showed that shoulder, neck and back discomfort and pain are more prevalent compared to other affected body parts.[24,30-32] A study comparing musculoskeletal symptoms among office workers, nurses and postal workers found that the prevalence rate of musculoskeletal symptoms on neck and shoulder were highest among office workers.[33] Findings in the current study indicate that these body regions are more susceptible due to several root causes. Chair height that is not setup properly is likely to introduce raised shoulder postures. A display or monitor unit that is not at a proper height contributes to poor neck postures, and input devices that are positioned farther away encourage workers to adopt forward bending of the back when operating the devices.[34-36]

Although not directly measured, the findings in this study suggest there is low ergonomics awareness among office workers. A cross-sectional study conducted in a developing country on 2500 office workers found that poor work habits were significantly associated with complaints of neck, shoulder and arms.[37] Other publications also reported similar findings about low ergonomics awareness and knowledge level among workers in developing economies.[38-39] The findings also suggest substandard design specifications of office furniture, especially for Malaysian populations. In many cases, maximum chair height adjustment is not high enough relative to the work surface, resulting in poor upper extremity postures. In addition, many office workers were observed using chairs with longer and non-adjustable seat pan depth, which consequently results in a noticeable gap between workers' low back and the back support of the chair. This design feature is likely to result in an unsupported lower back. Further investigation on literature, local office furniture manufacturer websites, and visits to multiple office furniture distributors revealed that there is a lack of established ergonomics design specifications on office furniture, especially for Malaysian population. There is a high likelihood that this issue is also applicable in other developing countries, especially those with limited comprehensive anthropometrical data of the population at national level. Substandard ergonomics furniture has been reported in other developing countries such as Thailand, Hong

Kong and Pakistan.[27,28,40]

Limitations of this study should be considered when interpreting the findings. The sampling of study is not random, but from clients requesting ergonomics assessment services at their offices. There is a likelihood that these workplaces have already received complaints from workers, which may affect the generalizability of the data sample. Future studies may extend into companies that are taking proactive ergonomics initiatives to represent a more representative population sample. In addition, the data were retrospective secondary data collected by ergonomists, which were mostly conducted through observation, interview, and self-report survey. This limits the type of data that was extracted and analyzed, as there was no collection of objective data such as postural angle, grip strengths, and specific dimensions of the furniture. Future studies may include objective data collection, which will allow more quantitative analysis.

Conclusions

This study is one of the first in Malaysia to investigate the office ergonomics from practitioners' ergonomics assessment reports. Overall, there is a high prevalence level of symptoms among study population. Gender and age groups were found to be associated with MSD symptom severity levels. Shoulders, lower back and neck were found to be the most common regions of discomfort and pain, with ergonomics risk factors attributed to poor postures, static loading, and contact stress among the study population. Root causes can be traced to improper workstation setup and poor work habits. Improvements to minimize risk factors exposure, through appropriate ergonomics design specifications of office furniture and continuous refresher courses to maintain basic ergonomics awareness may likely contribute to reduction of cumulative strains on body parts, consequently lower the prevalence of MSD symptoms among office workers.

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References

1. Social Security Organisation (SOCSO) [Internet]. 2020. [cited 2023 April 04]. Available from: https://www.perkeso.gov.my/en/about-us/media-centre/annual-report.html
2. Landry MD, Raman SR, Sulway C, Golightly YM, Hamdan E. Prevalence and risk factors associated with low back pain among health care providers in a Kuwait hospital. Spine. 2008 Mar 1;33(5):539-45. Available from: https://doi.org/10.1097/BRS.0b013e3181657df7
3. Delele M, Janakiraman B, Abebe AB, Tafese A, van de Water AT. Musculoskeletal pain and associated factors among Ethiopian elementary school children. BMC Musculoskeletal Disorders. 2018 Dec;19(1):1-8. Available from: https://doi.org/10.1186/s12891-018-2192-6
4. Widyanti A. Ergonomic checkpoint in agriculture, postural analysis, and prevalence of work musculoskeletal symptoms among Indonesian farmers: Road to safety and health in agriculture. Jurnal Teknik Industri. 2018 Jun 17;20(1):1-10. Available from: https://doi.org/10.9744/jti.20.1.1-10
5. Ziaei M, Choobineh A, Abdoli-Eramaki M, Ghaem H. Individual, physical, and organizational risk factors for musculoskeletal disorders among municipality solid waste collectors in Shiraz, Iran. Industrial Health. 2018 Feb 28;56(4):308-19. Available from: https://doi.org/10.2486/indhealth.2018-0011
6. Santos EC, Andrade RD, Lopes SG, Valgas C. Prevalence of musculoskeletal pain in nursing professionals working in orthopedic setting. Revista Dor. 2017 Oct;18:298-306. Available from: https://doi.org/10.5935/1806-0013.20170119
7. Albeeli A, Tamrin SB, Guan NY, Karuppiah K. Musculoskeletal Disorders and Its Association with

Self-reported Productivity: A Cross-sectional Study Among Public Office-workers in Putrajaya, Malaysia. Malaysian Journal of Medicine and Health Sciences. 2020 Dec;16(4):272-9. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://medic.upm.edu.my/upload/dokumen/20201202105949 37_MJMHS_0394.pdf

8. AlOmar RS, AlShamlan NA, Alawashiz S, Badawood Y, Ghwoidi BA, Abugad H. Musculoskeletal symptoms and their associated risk factors among Saudi office workers: A cross-sectional study. BMC Musculoskeletal Disorders. 2021 Dec;22(1):1-9. Available from: https://doi.org/10.1186/s12891-021-04652-4

9. Moom RK, Sing LP, Moom N. Prevalence of musculoskeletal disorder among computer bank office employees in Punjab (India): A case study. Procedia Manufacturing. 2015 Jan 1;3:6624-31. Available from: https://doi.org/10.1016/j.promfg.2015.11.002

10. Faryza E, Murad MS, Anwar S. A study of work related complaints of arm, neck and shoulder (CANS) among office workers in Selangor and Kuala Lumpur. Malaysian Journal of Public Health Medicine. Jan 1 2015;2:8-16. Available from: https://www.researchgate.net/publication/282923601_A_study_of_work_related_complaints_of_arm_neck_and_shoulder_cans_among_office_workers_in_Selangor_and_Kuala_Lumpur

11. Mahmud N, Kenny DT, Heard R, Mahmud N. Office ergonomics awareness and prevalence of musculoskeletal symptoms among office workers in the Universiti Teknologi Malaysia: A cross-sectional study. Malaysian Journal of Medicine and Health Sciences. 2011;1:8-29. Available from: https://www.researchgate.net/publication/223995090_Office_ergonomics_awareness_and_prevalence_of_musculoskeletal_disorders_among_office_workers_in_the_Universiti_Teknologi_Malaysia_A_cross_sectional_study

12. Rahman MN, Awalludin NF, Masood I, Hassan MF. Ergonomic risk factors associated with musculoskeletal disorders in computer workstation. International Journal of Applied Engineering Research. 2017;12(7):1355-9. Available from: https://www.ripublication.com/ijaer17/ijaerv12n7_38.pdf

13. Besharati A, Daneshmandi H, Zareh K, Fakherpour A, Zoaktafi M. Work-related musculoskeletal problems and associated factors among office workers. International Journal of Occupational Safety and Ergonomics. 2020 Jul 2;26(3):632-8. Available from: https://doi.org/10.1080/10803548.2018.1501238

14. WorksafeNB. Computer Workstation Ergonomics [Internet]. 2010. [cited 2023 July 04]. Available from: https://www.worksafenb.ca/media/61622/computer_workstation_ergonomics.pdf

15. Workplace Safety North. Musculoskeletal disorders (MSDs) [Internet]. 2013. [cited 2023 July 04]. Available from: https://www.workplacesafetynorth.ca/resources/musculoskeletal-disorder-safety-talk-take-ten

16. Garza JL, Catalano PJ, Katz JN, Huysmans MA, Dennerlein JT. Developing a framework for predicting upper extremity muscle activities, postures, velocities, and accelerations during computer use: The effect of keyboard use, mouse use, and individual factors on physical exposures. Journal of Occupational Environmental Hygiene. 2012 Dec 1;9(12):691-8. Available from: https://doi.org/10.1080/15459624.2012.728927

17. Harcombe H, McBride D, Derrett S, Gray A. Prevalence and impact of musculoskeletal disorders in New Zealand nurses, postal workers and office workers. Australian and New Zealand Journal of Public Health. 2009 Oct;33(5):437-41. Available from: https://doi.org/10.1111/j.1753-6405.2009.00425.x

18. Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 2012 Dec 15;380(9859):2163-96. Available from: https://doi.org/10.1016/S0140-6736(12)61729-2.

19. Woods V. Musculoskeletal disorders and visual strain in intensive data processing workers. Occupational Medicine. 2005 Mar 1;55(2):121-7.

Available from: https://doi.org/10.1093/occmed/kqi029

20. Eltayeb S, Staal JB, Kennes J, Lamberts PH, de Bie RA. Prevalence of complaints of arm, neck and shoulder among computer office workers and psychometric evaluation of a risk factor questionnaire. BMC Musculoskeletal Disorders. 2007 Dec;8(1):1-11. Available from: https://doi.org/10.1186/1471-2474-8-68

21. Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: Individual, ergonomic, and work organizational factors. Ergonomics. 1995 Apr 1;38(4):763-76. Available from: https://doi.org/10.1080/00140139508925148

22. Shariat A, Cardoso JR, Cleland JA, Danaee M, Ansari NN, Kargarfard M, et al. Prevalence rate of neck, shoulder and lower back pain in association with age, body mass index and gender among Malaysian office workers. Work. 2018 Jan 1;60(2):191-9. Available from: https://doi.org/10.3233/WOR-2738

23. Ardahan M, Simsek H. Analyzing musculoskeletal system discomforts and risk factors in computer-using office workers. Pakistan Journal of Medical Sciences. 2016 Nov;32(6):1425-9. Available from: https://doi.org/10.12669/pjms.326.11436

24. Cho CY, Hwang YS, Cherng RJ. Musculoskeletal symptoms and associated risk factors among office workers with high workload computer use. Journal of Manipulative and Physiological Therapeutics. 2012 Sep 1;35(7):534-40. Available from: https://doi.org/10.1016/j.jmpt.2012.07.004

25. Delshad MH, Tavafian SS, Kazemnejad A. Work-related musculoskeletal disorders among office workers in Shahid Beheshti University of Medical Sciences in Tehran, Iran. International Journal of Musculoskeletal Pain Prevention. 2017 Sep 10;2(3):293-8. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ijmpp.modares.ac.ir/article-32-8306-en.pdf

26. Lee S, Park MH, Jeong BY. Gender differences in public office workers' satisfaction, subjective symptoms and musculoskeletal complaints in workplace and office environments. International Journal of Occupational Safety and Ergonomics. 2018 Apr 3;24(2):165-70. Available from: https://doi.org/10.1080/10803548.2016.1272959

27. Chaiklieng S, Suggaravetsiri P, Boonprakob Y. Work ergonomic hazards for musculoskeletal pain among university office workers. Walailak Journal of Science and Technology (WJST). 2010;7(2):169-76. Available from: https://wjst.wu.ac.th/index.php/wjst/article/view/40

28. Reitenbach ME, Jochems AJ, Molenbroek JF, Ball R, van Eijk DJ. User experience of office chairs and anthropometrics of female Chinese and Hong Kong Chinese office and factory workers. The Ergonomics Open Journal 2009;2(1):1-12. Available from: https://doi.org/10.2174/1875934300902010001

29. Barbini N, Squadroni R. Aging of health workers and multiple musculoskeletal complaints. Giornale Italiano di Medicina del Lavoro ed Ergonomia. 2003 Apr 1;25(2):168-72. Available from: https://pubmed.ncbi.nlm.nih.gov/12872502/

30. Robertson MM, Ciriello VM, Garabet AM. Office ergonomics training and a sit-stand workstation: Effects on musculoskeletal and visual symptoms and performance of office workers. Applied Ergonomics. 2013 Jan 1;44(1):73-85. Available from: https://doi.org/10.1016/j.apergo.2012.05.001

31. Piranveyseh P, Motamedzade M, Osatuke K, Mohammadfam I, Moghimbeigi A, Soltanzadeh A, et al. Association between psychosocial, organizational and personal factors and prevalence of musculoskeletal disorders in office workers. International Journal of Occupational Safety and Ergonomics. 2016 Apr 2;22(2):267-73. Available from: https://doi.org/10.1080/10803548.2015.1135568

32. Calik BB, Atalay OT, Baskan E, Gokce B. Analyzing musculoskeletal system discomfort, work interference and risk factors of office workers with computer users. Clinical and Experimental Health Sciences. 2013 Oct 1;3(4):208-14. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5216294/

33. Harcombe H, Herbison GP, McBride D, Derrett S. Musculoskeletal disorders among nurses compared with two other occupational groups. Occupational Medicine. 2014 Dec 1;64(8):601-7. Available from:

https://doi.org/10.1093/occmed/kqu117

34. Mohammadipour F, Pourranjbar M, Naderi S, Rafie F. Work-related Musculoskeletal Disorders in Iranian Office Workers: Prevalence and Risk Factors. Journal of Medicine and Life. 2018 Oct;11(4):328-33. Available from: https://doi.org/10.25122/jml-2018-0054

35. Paksaichol A, Lawsirirat C, Janwantanakul P. Contribution of biopsychosocial risk factors to nonspecific neck pain in office workers: A path analysis model. Journal of Occupational Health. 2015;57(2):100-9. Available from: https://doi.org/10.1539/joh.14-0124-OA

36. Çelik S, Dirimeşe E, Taşdemir N, Çelik K, Arık T, Büyükkara İ. Determination of pain in muscoloskeletal system reported by office workers and the pain risk factors. International Journal of Occupational Medicine and Environmental Health. 2018;31(1):91-111. Available from: https://doi.org/10.13075/ijomeh.1896.00901

37. Ranasinghe P, Perera YS, Lamabadusuriya DA, Kulatunga S, Jayawardana N, Rajapakse S, et al. Work related complaints of neck, shoulder and arm among computer office workers: A cross-sectional evaluation of prevalence and risk factors in a developing country. Environmental Health. 2011 Dec;10(1):1-9. Available from: https://doi.org/10.1186/1476-069X-10-70

38. Valipour Noroozi M, Hajibabaei M, Saki A, Memari Z. Prevalence of musculoskeletal disorders among office workers. Jundishapur Journal of Health Sciences. 2015 Jan 1;7(1):e27157. Available from https://doi.org/10.5812/jjhs.27157

39. Helali F, Lönnroth EC, Shahnavaz H. Participatory ergonomics intervention in an industrially developing country—a case study. International Journal of Occupational Safety and Ergonomics. 2008 Jan 1;14(2):159-76. Available from: https://doi.org/10.1080/10803548.2008.11076760

40. Ahmed I, Shaukat MZ. Computer users' ergonomics and quality of life–evidence from a developing country. International Journal of Injury Control and Safety Promotion. 2018 Apr 3;25(2):154-61. Available from: https://doi.org/10.1080/17457300.2017.1415361