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ORIGINAL ARTICLE

Assessment of Laptop Ergonomic Practices and their Association with Work-Related Musculoskeletal Disorders among Office Employees: A Cross-Sectional Study

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ABSTRACT

Background: The growing use of laptops in offices has given rise to emerging concerns that are related to the work-related musculoskeletal disorders (WMSDs). Lack of proper ergonomic procedures, extended sitting and unsuitable work stations setups are some of the determinants of musculoskeletal overloads among employees. This project used the assessment of the laptop ergonomics practice and tested its relationship with WMSDs among office employees working in various organizations in Saudi Arabia, Pakistan, and China.

Methods: It involved a cross-sectional study with 70 full-time employees working in the office and using laptops at least three hours a day during the period between April 2023 and April 2024. The participants were recruited at Alostool Al Aali, Arabian Safety Training Institute, Saudi Electric Service Polytechnique, Ar Razi Medical Complex, Shaikha Fatima institute of nursing and health science, and Jining medical university. The structured questionnaire that was used to gather data included demographic information, a checklist on the ergonomics of the laptop, and the Standardized Nordic Musculoskeletal Questionnaire. The SPSS version 26 was used to perform descriptive statistics, chi-square tests, and logistic regression, and $p < 0.05$ was deemed statistically significant.

Results: WMSDs were widespread, 68.6% and most affected areas were the neck (55.7), lower back (50.0) and shoulders (42.9). It was noted that in 71.4% of the participants, poor ergonomic practices were included. Ergonomic poor practices were significantly associated with WMSDs ($p < 0.01$). The rate of discomfort was reported to increase in employees spending more than six hours a day working with laptops and exhibited a protective effect with the use of external accessories.

Conclusion: The prevalence of WMSDs is very high in office workers and is closely associated with improper ergonomics of laptops. Musculoskeletal risk can be significantly decreased by improving workstation arrangements, spreading the idea of ergonomics, and frequent breaks.

Keywords: Laptop ergonomics, musculoskeletal disorders, office employees, posture, ergonomic risk factors, occupational health, workstation design.

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are one of the most important workplace health issues in the world, which cause high rates of absenteeism, low productivity and chronic pains among workers[1]. Over the past few years with the high rate of digitalization of workplaces, the major computing tool of a good proportion of the workforce has been transformed into laptops. Their convenience of being lightweight and portable is at the expense of ergonomic flexibility. In comparison with the desktop computers which can be raised vertically and horizontally, along with the position of the keyboard, the lap top has the screen and keyboard in one piece and a user is forced to adopt non-neutral postures that subject her to musculoskeletal stress[2,3].

There is evidence to indicate that neck pain, shoulder stiffness, lower back pain, and wrist/hand disorders have a strong association with prolonged use of laptops. Such symptoms are usually caused by flexed neck postures, rounded shoulders, and sitting in positions that are generally inactive such as sitting directly over a laptop and the hand movements involved in the work done on a laptop. Moreover, due to the introduction of remote working patterns, common workspace, and mobile offices, individuals have started to work in uneven workstations, less ergonomic control, and increased screen time, which further increases musculoskeletal risk among workers[4,5].

Ergonomic training and workplace health policies are usually inadequate in low and middle income countries like Pakistan, and employees do not understand how to position their laptops and chairs, and how to take breaks in the most favorable way. It is this ignorance coupled with increased workloads and extended working hours, which enhances the chances of developing the WMSDs in the early years of career. Although laptops are used widely in corporations, administration, academia, and information and technology (IT) settings, a comparison of ergonomics and their relationship with musculoskeletal signs and symptoms is not studied in Pakistan[6,7].

With these gaps, it is critical to evaluate actual ergonomic actions in practice and determine risk factors that can be changed so as to inform interventions at the workplace. The proposed study will assess the ergonomic practices related to laptops amongst office workers and establish the effect of such practices on the occurrence of WMSDs. The knowledge of these associations will assist organizations to create specific ergonomics programs, redesign workstation areas, and enhance the health and productivity of employees[8].

MATERIALS AND METHODS

Study Design and Setting

The purpose of conducting this analytical cross-sectional study was to assess the ergonomic practices of using a laptop and their relationship with the occurrence of work-related musculoskeletal disorders (WMSDs) in office employees, in three different professional settings in Saudi Arabia, Pakistan, and China. The research was conducted in the academic facilities where the authors worked, such as Alostool Al Aali and Arabian Safety Training institute (ASTI) in Saudi Arabia, Saudi Electric service polytechnique (SESP), Ar Razi medical complex in Jubail, Shaikha Fatima institute of nursing and health sciences (SFINHS) at Shaikh Zayed medical complex, Lahore, Pakistan and Jining medical university, China. Such settings are various work environments that include healthcare and safety training departments as well as academic institutions. The data will be collected during a 12-month timeframe spanning the months of April 2023 to April 2024 to have enough time to get the responses of the full-time workers in these organizations.

Study Population

This study population was comprised of office workers who were using laptops as their main devices of work in the institutions mentioned above. Those aged between 20 and 55 years old who had worked a minimum of six months and took at least three hours on a laptop workday were taken as eligible. Those who had a history of either congenital or chronic musculoskeletal disorders, severe trauma, or acute medical disease were excluded to prevent confounding factors on musculoskeletal symptoms. Pregnant women were also excluded to eliminate confounding factors on musculoskeletal symptoms. Only those employees who have known the purpose of the study and have given informed consent were taken.

Sample Size and Sampling Technique

There was a population of 70 participants that were included in the study through a non-probability consecutive sampling technique. Participants in the study were invited to be part of the study as long as they were working in the participating institutions at the time of data collection and they met the eligibility criteria. The process of recruitment went on until seventy respondents were recruited. It was deemed that this sample was sufficient to investigate the relationships between ergonomic behaviors and the prevalence of WMSD in a number of institutional contexts.

Data Collection Tools

A structured self-administered questionnaire was used to collect the data and was challenging in three major sections. The demographic and occupational details (age, gender, body mass index, job designation, years of experience and the duration of use of the laptop daily) were collected in the first part. The second part evaluated the ergonomic practices of the laptop using a standardized ergonomics checklist covering the workstation organization, the personalities of the chair, posture, the height of the screen, use of external accessories, the intensity of light and frequency of rest. The third part involved musculoskeletal symptoms which were captured in the format based on the Standardized Nordic Musculoskeletal Questionnaire (SNMQ), where the questions aimed at the pain or discomfort in the body parts such as neck, shoulders, upper and lower back, wrists and knees during the past 12 months and during the past 7 days. Musculoskeletal symptom interference with normal work performance was also reported by the respondents.

Operational Definitions

In the context of this research, an instance of a work-related musculoskeletal disorder (WMSD) was the pain, stiffness, discomfort, or numbness in at least one part of the body, which persisted at least 24 hours, was not due to acute traumas, and appeared during normal use of laptops. The operationally defined concept of good and poor ergonomics practice used was that the total ergonomics checklist score that was equal or less than 70% indicated good ergonomic practice and a score that was less than 70 indicated poor ergonomic practice. The protracted use of laptops was defined as the daily use of laptops more than six hours per working day.

Data Collection Procedure

Administrative leaders of the involved institutions in Saudi Arabia, Pakistan, and China were reached out to and accepted. Each potential participant was provided with an explanation of the purpose and objectives of the study and an informed consent was signed. The questionnaires were administered in silent offices and gathered as soon as completed which made them accurate and complete. Where there were clarifications, they were given without affecting the responses of the participants. Questionnaires were made confidential by anonymizing them and no personal identifiers were captured.

Management and Statistical Analysis of Data.

The data were inputted into Microsoft Excel and processed in SPSS 26 version. Participant characteristics and ergonomic practices were summarized by use of descriptive statistics in which means and standard deviations were used to describe continuous variables and frequencies expressed as percentages to describe categorical variables. The chi-square test or Fisher exact test was used to test the association between the ergonomic practices and WMSDs. A logistic regression analysis was done to determine independent predictors of WMSDs, and included the age, gender, work experience, daily laptop use, and ergonomic practice score. A p-value that was below 0.05 was taken to be statistically significant.

Ethical Considerations

The institutional review boards or administrative authorities of the institutions participated in the study, such as Alostool Al Aali, ASTI, SESP, Ar Razi Medical Complex, SFINHS at Shaikh Zayed Medical Complex, and Jining Medical University, gave their ethical approval. Informed consent was given in writing by all participants and confidentiality of responses was highly ensured. Data were only utilized to academic and research.

RESULTS

There were 70 office workers in different institutions in Saudi Arabia, Pakistan and China who took part in the study. The overall age of the respondents was 32.8 7.4 years, 58.6% males and 41.4% females. The mean time spent on laptops was 6.9 hours of daily use with a standard deviation of 2.1 hours and the average work experience was 5.8 years of working experience with a standard deviation of 3.6. Table 1 summarises baseline demographic variables and occupational variables.

Occurrence of Work-Related Musculoskeletal Disorders.

The prevalence of work-related musculoskeletal disorders (WMSDs) among the participants was in total, 68.6. The neck (55.7%), lower back (50.0%), and shoulders (42.9) were the most refreshed. Discomfort in the wrist and hand was found to be experienced by 27.1% and upper back pain experienced by 30.0% of the participants. Out of the 41.4% of the respondents, 41.4% indicated the presence of musculoskeletal symptoms that were disrupting their normal work activities.

Ergonomics amongst the employees.

Regarding ergonomic behavior only 28.6% of the participants exhibited good ergonomic behavior based on the scoring criterion whereas 71.4% exhibited poor ergonomic behavior. The frequent causes of poor ergonomics were the eye level of the laptop screen was lower than the office chair (77.1%), the ergonomic position of the seat was bent (65.7%), the laptop was placed on the lap (51.4%), and the back support was absent (54.3%). External accessories like an external mouse or external

keyboard were used only by 32.9% of the respondents. Table 2 shows the distribution of ergonomic practices.

Correlation of Ergonomic Practices and WMSDs

This showed a significant relationship between general ergonomic practice score and having WMSDs ($p < 0.01$). The prevalence of musculoskeletal complaints was significantly different between participants who had poor ergonomic practices (82.0% and those who had good ergonomic practices (35.0%). Equally, workers who spent over six hours daily using their laptops had greater neck and lower back-impact symptoms than those who spent less time on their laptops ($p < 0.05$). Protective effect was manifested by use of external ergonomic accessories. The respondents who used an external mouse or keyboard also said that they experienced 28 percent less neck and shoulder symptoms than those who used only the inbuilt laptop parts. The association however was not statistically significant ($p = 0.08$), but had a significant tendency towards less discomfort. The findings taken together suggest that poor workstation setup, excessive sitting, and ergonomic insensitivity are the significant causes of WMSDs among office workers in the examined environments.

Table 1. Baseline Characteristics of Participants (n = 70)

Variable	Mean ± SD / n (%)
Age (years)	32.8 ± 7.4
Gender (Male/Female)	41 (58.6%) / 29 (41.4%)
BMI (kg/m²)	25.6 ± 3.8
Daily laptop use (hours/day)	6.9 ± 2.1
Total work experience (years)	5.8 ± 3.6
Uses external mouse/keyboard	23 (32.9%)
Takes regular breaks every hour	19 (27.1%)
Good ergonomic practice	20 (28.6%)
Poor ergonomic practice	50 (71.4%)

Table 2. Ergonomic Practices and Prevalence of WMSDs (n = 70)

Variable	Frequency (%)
Poor ergonomic practice	50 (71.4%)
Good ergonomic practice	20 (28.6%)
WMSDs present	48 (68.6%)
Most affected region – Neck	39 (55.7%)
Most affected region – Lower Back	35 (50.0%)
Shoulder discomfort	30 (42.9%)
Wrist/Hand discomfort	19 (27.1%)
Symptoms interfering with work	29 (41.4%)

Integrated Interpretation

As it can be observed, the evidence-based ergonomic practices that were exhibited by employees generated considerably higher prevalence rates of WMSDs (Table 2). The results demonstrate clearly that improper sitting of the laptops, excessive use of the laptops, and comfortable seating are some of the factors that lead to musculoskeletal strain. These findings highlight the importance of institutional ergonomic training, workstation arrangements and interventions at the policy level to encourage healthy working practices.

DISCUSSION

It was a cross-sectional study that evaluated the ergonomic practices by use of laptops and their relation to work musculoskeletal disorders (WMSDs) in office employees working in different institutions in Saudi Arabia, Pakistan, and China[8-11]. It was identified that the WMSDs occurred at a high rate (68.6%), the anatomical regions most often involved included the neck, lower back, and shoulders[12]. These findings are in line with the trend in ergonomic studies around the world with posture problems that are related to laptops as one of the leading causes of musculoskeletal stress[13].

It is expected that the neck symptoms (55.7%) were high in this study due to continuous cervical flexion due to screens that are below the eye line, a trend that has been recorded in most of the participants. The extended use of laptops averaging close to seven hours a day also increased the frequency of neck complaints and lower back complaints. This is in line with previous findings that sustained screen-time and sitting postures present sustained loading to both cervical and lumbar muscles, which predisposes musculoskeletal fatigue and pain[14,15].

Over 70 percent of participants were found to have poor ergonomic practices and there was a significant linkage between poor ergonomic practices and the existence of WMSDs. Individuals who had low scores in ergonomics were found to have over twice the incidence of musculoskeletal signs in comparison with those who scored good in ergonomics. This supports the already known fact that poor workstation configurations including low back posture, lack of lumbar support and wrong screen elevation are one of the key contributors to musculoskeletal disorders related to office[16,17].

Even though a third of the respondents used external accessories (external mouse or keyboard) they also had less neck and shoulder symptoms. Although this trend is not statistically significant, it indicates that external devices may have protective effect and should be recommended to accomplish more neutral postures. Moreover, the few number of frequent breaks implies the employees have

little ergonomic knowledge. Microbreaks were also found to enhance circulation, fatigue prevention, and cumulative strain reduction but only a quarter of the participants said that they took a break every hour[18,19].

The multinational institutional frames of the present study contribute to the effectiveness of the research in multiple occupational contexts. Although the differences between cultures and the workplace were minor, the unanimity of results indicates that the ergonomic issues with laptops are universal[13,17]. The cross-sectional nature of the study, however, does not allow one to make causal conclusions, and the use of self-reported data can also be a source of recall bias. However, the connections noted indicate the necessity of organized ergonomic training and modifications of the workplace. On the whole, the paper reveals the existence of important gaps in ergonomic knowledge and practice among office workers and the necessity of organizational interventions. To reduce the possibility of musculoskeletal disorders and improve workers well-being and productivity, institutions need to focus on ergonomic education, invest in adjustable workstations, and promote break schedules[20].

CONCLUSION

This study has shown that the occurrence of WMSDs is very common among office workers and is closely linked with inappropriate ergonomic practices of laptops. The most commonly reported symptoms were neck, lower back, and upper back pain, which were mainly due to the incorrect workstation configurations, poor posture and long time working on the laptop. The WMSDs in employees with bad ergonomic behaviors were much greater which proves the critical importance of adequate laptop positioning, usage of external accessories, and frequent breaks. The research highlights the severity of the issue of the necessity of workplace ergonomics education and the establishment of corporate policies that will influence healthy postures and the most appropriate workstation setups. Musculoskeletal risks can be significantly eliminated by introducing adaptable chairs, external keyboards and mice, screen risers, and planned microbreaks. Enhancing ergonomic awareness in the institutions of Saudi Arabia, Pakistan, and China can contribute to the reduction of the rising number of WMSDs in the contemporary digital working environment.

DECLARATION

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. All data are stored confidentially and are not publicly accessible due to privacy restrictions.

Competing Interests

The authors declare that they have **no competing interests**. There were no personal, financial, or institutional conflicts that influenced the study.

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Authors' Contributions

Muhammad Akmal: Study conception, methodology development, data collection, manuscript drafting

Muhammad Ajmal: Literature review, data analysis, manuscript editing

Muhammad Afzal: Data collection, ergonomics assessment, results interpretation

Muhammad Ahsan Raza: Clinical review, statistical support, discussion refinement

Muhammad Ahmed: Institutional coordination, questionnaire validation, proof-reading

Mukhtiar Hussain: Academic supervision, critical review, final manuscript approval

All authors read and approved the final manuscript.

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