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(CASE STUDY)

Assessment of office ergonomic risks among network operation center employees using rapid office strain assessment and Nordic body map: A case study

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Abstract

Prolonged computer-based work and static sitting posture are common characteristics of Network Operation Center (NOC) activities. These working conditions may increase the risk of musculoskeletal disorders, particularly when workstation facilities do not support ergonomic working posture. This case study aimed to assess office ergonomic risks and identify musculoskeletal complaints among NOC employees using the Rapid Office Strain Assessment (ROSA) and Nordic Body Map (NBM) methods. The study involved eight NOC employees who performed continuous network monitoring activities for approximately eight hours per day. Data were collected through direct observation, workstation documentation, ROSA assessment, and NBM questionnaires. The ROSA results showed that all respondents had final scores ranging from 7 to 8, indicating a high ergonomic risk level that requires immediate corrective action. The NBM results showed that the most frequent and severe complaints were reported in the lower back, back, upper neck, and lower neck regions. These complaints were associated with prolonged sitting duration, non-adjustable chairs, inadequate back support, improper monitor placement, and suboptimal keyboard and mouse positioning. The findings indicate that the current workstation design does not adequately support office ergonomic principles. Improvement recommendations include workstation adjustment, provision of ergonomic chairs, proper monitor and input device positioning, regular stretching, and ergonomic awareness programs.

Keywords: Office Ergonomics; Musculoskeletal Disorders; Network Operation Center; Nordic Body Map; Rapid Office Strain Assessment; Workstation Design

1. Introduction

The rapid development of information and communication technology has increased the dependence of modern office activities on computer-based work systems. In many organizational settings, employees are required to work in front of computer screens for extended periods, often in a static sitting posture. This condition is particularly evident in Network Operation Center (NOC) activities, where employees are responsible for monitoring network performance, identifying service disruptions, and ensuring the continuity of internet or digital infrastructure services. Although this type of work is not physically intensive in terms of heavy manual handling, prolonged sitting, repetitive keyboard and mouse use, and poor workstation configuration may create significant ergonomic risks.

Office ergonomics is concerned with the interaction between workers, workstation design, equipment, work methods, and the surrounding work environment. A properly designed office workstation should support neutral body posture, reduce unnecessary muscle load, and allow employees to work comfortably and efficiently. Conversely, mismatches between workstation facilities and workers' physical requirements may lead to awkward posture, static muscle loading, visual fatigue, and discomfort in several body regions. In computer-based work, common ergonomic risk factors include

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inappropriate chair height, insufficient lumbar support, unsuitable monitor position, inadequate arm support, excessive reaching distance to the mouse, and non-neutral wrist position during keyboard use [1,2].

One of the major health concerns associated with poor office ergonomics is musculoskeletal disorders (MSDs). MSDs refer to disorders or complaints affecting muscles, tendons, ligaments, joints, nerves, and other supporting structures of the body. Among office workers, MSDs are frequently reported in the neck, shoulders, back, lower back, arms, wrists, and hands. These complaints may arise from prolonged static posture, repetitive movement, insufficient recovery time, and workstation designs that do not accommodate the user's anthropometric characteristics. If such conditions persist, they may reduce worker comfort, decrease productivity, increase fatigue, and contribute to absenteeism or long-term occupational health problems [3,4].

Employees working in NOC environments are exposed to specific ergonomic challenges. Their tasks require continuous attention to multiple screens, rapid responses to network conditions, and prolonged computer operation. In some cases, employees may use more than one monitor, remain seated for most of the work shift, or adjust their posture to compensate for non-adjustable chairs and desks. Without proper ergonomic standards, these working conditions may increase the likelihood of discomfort in the neck, back, lower back, shoulders, arms, and wrists. Therefore, ergonomic assessment is necessary to identify workstation-related risk factors and to formulate practical recommendations for improvement.

Several methods can be used to evaluate ergonomic risks and musculoskeletal complaints in office work. The Rapid Office Strain Assessment (ROSA) is a method specifically developed to assess ergonomic risks in computer-based office workstations. ROSA evaluates several workstation components, including chair, monitor, telephone, mouse, and keyboard, while also considering the duration of exposure. The final ROSA score indicates the level of ergonomic risk and whether corrective action is required [5,6]. In addition to observational assessment, the Nordic Body Map (NBM) questionnaire is commonly used to identify subjective musculoskeletal complaints in different body regions. NBM allows researchers to map the location and severity of discomfort experienced by workers, making it useful for complementing observational ergonomic assessment [7].

Although ergonomic studies in office environments have been widely conducted, case-based evaluations in NOC work settings remain important because of the unique characteristics of the job. NOC employees perform continuous monitoring tasks that combine long sitting duration, high visual attention, repetitive input device use, and limited posture variation. These conditions require an integrated assessment approach that not only evaluates workstation risk objectively but also captures the physical complaints experienced by employees. The combination of ROSA and NBM is therefore relevant because ROSA identifies potential ergonomic risk sources from workstation components, while NBM describes the body regions most affected by the existing work conditions.

This study was conducted as a case study among NOC employees in an Indonesian company. The objective of this study was to assess the level of office ergonomic risk using the ROSA method, identify musculoskeletal complaints using the NBM questionnaire, and formulate improvement recommendations based on office ergonomic principles. The findings of this study are expected to provide practical input for improving workstation design, promoting healthier working posture, and reducing the risk of musculoskeletal complaints among computer-based office workers, particularly in NOC environments.

2. Materials and Methods

2.1. Study design

This study was designed as a descriptive case study aimed at evaluating office ergonomic risks and musculoskeletal complaints among Network Operation Center (NOC) employees. A case study approach was selected because the research focused on a specific work unit in a case company, where employees performed continuous computer-based network monitoring activities. The assessment combined observational ergonomic evaluation using the Rapid Office Strain Assessment (ROSA) method and subjective musculoskeletal complaint mapping using the Nordic Body Map (NBM) questionnaire.

The study was conducted in the NOC division of a case company located in Bandung, Indonesia. Data collection was carried out during the practical work period from 5 January to 30 January 2026. The main focus of the study was to identify workstation-related ergonomic risk factors and body regions with musculoskeletal complaints among employees who worked in prolonged sitting postures.

2.2. Study participants

The participants consisted of eight employees working in the NOC division of the case company. All employees in the observed NOC work unit were included as respondents; therefore, the study used a total sampling approach. The respondents were involved in computer-based monitoring activities for approximately eight hours per working day.

The inclusion criteria were employees who worked in the NOC division, used computer workstations as their primary work facility, and were willing to participate in the assessment. Employees who were not present during the observation period or did not complete the questionnaire were excluded from the study. The respondent profile included gender, work division, length of employment, and age.

2.3. Research variables

The variables observed in this study consisted of ergonomic risk factors and musculoskeletal complaints. Ergonomic risk factors were assessed based on workstation components included in the ROSA method, namely chair, monitor, telephone, mouse, and keyboard. These components were evaluated in relation to working posture, equipment position, workstation adjustability, and duration of use.

Musculoskeletal complaints were assessed using the NBM questionnaire. The questionnaire identified discomfort or pain in several body regions, including the neck, shoulders, back, lower back, arms, wrists, thighs, knees, calves, ankles, and feet. The NBM results were used to determine the distribution and severity of complaints experienced by the respondents.

2.4. Data collection

Data were collected using primary and secondary sources. Primary data were obtained through direct observation of employees during computer-based work, documentation of working postures and workstation conditions, ROSA assessment, and NBM questionnaire distribution. The observation focused on actual working postures adopted by employees during their routine NOC activities.

Workstation documentation was conducted to support the ergonomic assessment. Photographs were used to observe the position of the chair, monitor, keyboard, mouse, and other related work facilities. These observations provided information on whether the workstation supported neutral posture or created potential ergonomic risks.

Secondary data were obtained from literature related to office ergonomics, musculoskeletal disorders, ROSA, and NBM. These references were used to support the theoretical framework, interpret the findings, and formulate ergonomic improvement recommendations.

2.5. Nordic Body Map assessment

The Nordic Body Map questionnaire was used to identify subjective musculoskeletal complaints experienced by the respondents. The questionnaire consisted of body regions from the neck to the feet. Each respondent was asked to indicate the level of discomfort or pain felt in each body region after performing their work activities.

The scoring system used in the NBM assessment was as follows: 1 = no pain, 2 = slight pain, 3 = pain, and 4 = severe pain. The scores from all body regions were then summed to obtain the total individual score for each respondent. The total score was used to classify the level of musculoskeletal disorder risk. In addition, the scores of each body region were aggregated across all respondents to identify the body parts with the highest complaint levels.

The NBM data were analyzed descriptively by calculating the total score, percentage, and ranking of complaints for each body region. This analysis helped identify which parts of the body were most affected by prolonged computer-based work and static sitting posture.

2.6. Rapid Office Strain Assessment

The Rapid Office Strain Assessment method was used to evaluate ergonomic risks in computer-based office workstations. ROSA was selected because it is specifically designed to assess office work involving computer use. The method evaluates several workstation components that influence working posture and physical strain.

- The ROSA assessment was divided into three main sections
- Section A: Chair assessment

This section evaluated chair height, seat depth, armrest condition, and backrest support. The assessment also considered whether the chair could be adjusted according to the worker's body dimensions.

- Section B: Monitor and telephone assessment

This section evaluated monitor position, viewing distance, screen height, use of multiple monitors, telephone use, and the availability of supporting devices such as hands-free equipment or document holders.

- Section C: Mouse and keyboard assessment

This section evaluated the position and use of the mouse and keyboard, including reaching distance, wrist posture, keyboard height, and whether the input devices were placed on an adjustable platform.

Each section was scored according to the ROSA assessment procedure. The duration of equipment use was also considered in the scoring process. Since the respondents used computer workstations for more than four hours per day, a duration adjustment was applied in accordance with the ROSA method. The final ROSA score was then used to classify the ergonomic risk level. A score of 1–5 indicates low risk, while a score of 6–10 indicates high risk and requires further workstation review and corrective action.

2.7. Data analysis

The data analysis was conducted descriptively. The NBM results were analyzed by calculating the total individual score of each respondent and the total complaint score for each body region. The body regions with the highest scores were interpreted as the most dominant complaint areas among NOC employees.

The ROSA results were analyzed by calculating the scores for Section A, Section B, Section C, peripheral components, and the final ROSA score. The final score was then compared with the ROSA risk classification to determine whether the workstation condition was categorized as low or high risk.

The findings from the NBM and ROSA assessments were then compared to identify the relationship between workstation-related ergonomic risks and musculoskeletal complaints. For example, high chair-related ROSA scores were interpreted in relation to complaints in the back and lower back, while monitor-related risk factors were interpreted in relation to neck complaints. This integrated analysis was used as the basis for formulating ergonomic improvement recommendations.

2.8. Ethical consideration

The study was conducted by observing employees during normal work activities without interfering with their tasks. Respondents were informed about the purpose of the assessment, and participation in the questionnaire was voluntary. The identity of the company and respondents was anonymized to maintain confidentiality. The collected data were used only for academic and research purposes.

3. Results and Discussion

3.1. Characteristics of respondents

This case study involved eight employees working in the Network Operation Center (NOC) division of the case company. All respondents performed computer-based monitoring activities as their main daily task. The respondents consisted of four male and four female employees, with ages ranging from 20 to 46 years. Their work tenure varied from three months to nine years.

Table 1 Characteristics of respondents

Respondent	Sex	Work division	Work tenure	Age
A	Male	NOC	6 months	20 years
B	Male	NOC	3 months	20 years
C	Female	NOC	1 year	21 years
D	Female	NOC	5 years	28 years
E	Male	NOC	7 months	20 years
F	Female	NOC	4 years	24 years
G	Male	NOC	9 years	46 years
H	Female	NOC	4 years	27 years

The respondent profile indicates that ergonomic risks in the NOC work environment may affect employees with different ages and work experience levels. Although some respondents were relatively young and had short work tenure, they were still exposed to prolonged computer-based work. This condition suggests that ergonomic risks in office work are not only associated with age or length of employment, but also with daily exposure to static sitting posture, workstation design, and repetitive computer use.

3.2. Nordic Body Map results

The Nordic Body Map (NBM) questionnaire was used to identify subjective musculoskeletal complaints experienced by the respondents. The total NBM score obtained from all respondents and all body regions was 356. The highest complaint score was found in the lower back or waist region, with a score of 20. This was followed by the back with a score of 19, upper neck with a score of 16, and lower neck with a score of 15. Other body regions with relatively high complaint scores included the right shoulder, buttocks, left lower arm, right lower arm, and right wrist, each with a score of 14. These values are based on the NBM data processing in the original draft.

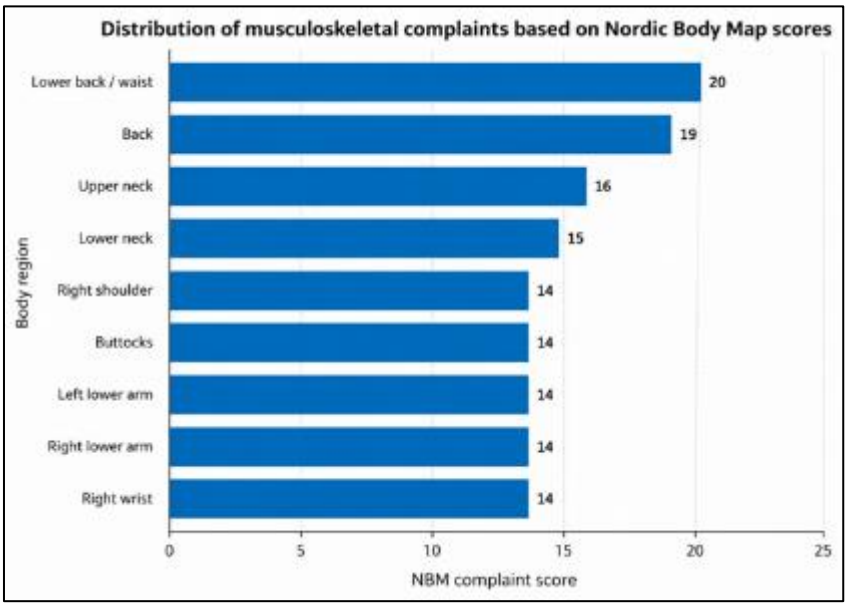

Figure 1 Distribution of musculoskeletal complaints based on Nordic Body Map scores

The distribution of complaints shown in Figure 1 indicates that the most affected body regions were mainly located in the spinal and upper extremity areas. Complaints in the lower back and back may be related to prolonged sitting posture and insufficient support from the chair. In office work, sitting for long periods without adequate lumbar support can increase static muscle loading and pressure on the spine. This finding is consistent with previous studies which reported

that poor workstation design and prolonged sitting are important contributors to musculoskeletal discomfort among office workers [1,2].

The high complaint scores in the upper and lower neck regions suggest that monitor placement may not have been properly adjusted to the respondents' eye level. When the monitor is positioned too high, too low, or too far from the user, employees tend to maintain awkward neck postures for extended periods. This condition is particularly relevant in NOC activities, where employees are required to continuously observe screens and respond to network conditions.

Complaints in the shoulder, lower arms, and right wrist indicate potential strain related to repetitive keyboard and mouse use. Excessive reaching distance to the mouse, lack of arm support, and non-neutral wrist posture may increase discomfort in the upper limbs. Similar findings have been reported in ergonomic studies of computer-based work, where repetitive input device use and unsupported arm posture were associated with complaints in the shoulders, arms, wrists, and hands [3,4].

3.3. Individual musculoskeletal risk classification

The total NBM score for each respondent was classified to determine the individual level of musculoskeletal disorder risk. The results showed that five respondents were classified as low risk, while three respondents were classified as moderate risk.

Table 2 Individual classification of musculoskeletal complaints based on NBM

Respondent	Total individual score	MSDs risk level
A	42	Low
B	34	Low
C	43	Low
D	64	Moderate
E	50	Moderate
F	62	Moderate
G	29	Low
H	32	Low

Respondents D, E, and F were categorized as having moderate musculoskeletal disorder risk, with total scores of 64, 50, and 62, respectively. Respondent D had the highest total individual score, indicating a higher level of perceived discomfort compared with the other respondents. Meanwhile, respondents A, B, C, G, and H were classified as low risk.

Although most respondents were still categorized as low risk based on the NBM classification, the presence of three moderate-risk respondents shows that musculoskeletal complaints had already emerged in the observed work unit. Subjective complaints should be considered as early warning signs because discomfort may develop into more serious musculoskeletal disorders if the exposure continues without ergonomic intervention.

The variation in individual NBM scores may be influenced by several factors, including working posture, workstation adjustment, anthropometric differences, work tenure, individual physical condition, and personal perception of pain. However, because all respondents performed similar computer-based monitoring activities, the findings suggest that the workstation condition and working habits contributed to the occurrence of musculoskeletal discomfort.

3.4. Rapid Office Strain Assessment results

The Rapid Office Strain Assessment (ROSA) method was used to evaluate ergonomic risk in the respondents' computer-based workstations. The assessment included chair condition, monitor and telephone use, mouse and keyboard placement, monitor and peripheral components, and duration of exposure. Since the respondents used computer workstations for more than four hours per day, the duration factor contributed to the final ROSA score.

Table 3 ROSA score recapitulation

Respondent	Chair score	Monitor and telephone score	Mouse and keyboard score	Monitor and peripherals score	Final ROSA score	Risk category
A	8	6	6	6	8	High
B	8	4	6	6	8	High
C	8	4	6	6	8	High
D	8	6	6	6	8	High
E	8	4	6	6	8	High
F	8	3	6	6	8	High
G	8	4	6	6	8	High
H	7	3	6	6	7	High

The ROSA results showed that all respondents were categorized as high risk, with final scores ranging from 7 to 8. Seven respondents obtained a final score of 8, while one respondent obtained a final score of 7. According to the ROSA classification, scores in this range indicate that workstation conditions require further review and immediate corrective action. These results confirm that ergonomic risk was present across all observed workstations.

The chair component made a major contribution to the high ROSA scores. Most respondents had a chair score of 8, while one respondent had a score of 7. The main chair-related problems included non-adjustable seat height, unsuitable seat depth, absence of armrests, and inadequate back support. These conditions may force employees to sit in awkward postures and may increase pressure on the lower back and spinal region. This finding is consistent with the NBM results, where the highest complaints were reported in the lower back and back.

The monitor and telephone component showed scores ranging from 3 to 6. Several observed workstations had monitors that were too far, too high, or too low. In addition, some employees used more than one monitor, which may require repeated neck rotation during work. These conditions may contribute to neck discomfort, as shown by the high NBM scores in the upper and lower neck regions. Previous research on office ergonomics also emphasizes that inappropriate monitor placement is one of the important risk factors for neck and shoulder discomfort among computer users [5,6].

The mouse and keyboard component showed a score of 6 for all respondents. This indicates that input device placement was a common ergonomic issue in the observed NOC workstations. The mouse was often positioned too far from the user, requiring excessive reaching. In addition, the keyboard position and height did not fully support neutral wrist posture. These conditions may explain the complaints reported in the right shoulder, lower arms, and right wrist. Studies on computer-based office work have similarly reported that repetitive keyboard and mouse use, combined with non-neutral wrist and arm posture, may increase the risk of upper limb discomfort [2,4].

3.5. Relationship between NBM and ROSA findings

The NBM and ROSA results provide complementary evidence regarding ergonomic risk in the NOC work environment. The NBM results identified the body regions where respondents experienced discomfort, while the ROSA results identified workstation components that may have contributed to those complaints.

The highest NBM complaints were found in the lower back and back regions. This pattern is consistent with the high ROSA scores for the chair component. Chairs without proper adjustability, armrests, and lumbar support may increase static loading on the spine, especially when employees sit for long periods. Since NOC employees perform monitoring tasks for approximately eight hours per day, inadequate chair support may contribute to accumulated discomfort in the back and lower back.

Neck complaints were also prominent in the NBM results. This finding is consistent with ROSA observations related to monitor placement. Improper monitor height and viewing distance may cause forward head posture, neck flexion, neck extension, or repeated neck rotation. These postures are particularly relevant in NOC work because employees need to maintain visual attention on one or more screens throughout the work shift.

Complaints in the shoulder, lower arms, and right wrist were consistent with the ROSA findings for the mouse and keyboard component. Improper placement of input devices may lead to shoulder elevation, unsupported forearms, wrist deviation, and repetitive hand movements. These risk factors can increase discomfort in the upper extremities.

An important finding of this study is the difference between the NBM and ROSA classifications. Based on NBM, most respondents were still classified as low risk, while three respondents were classified as moderate risk. However, based on ROSA, all respondents were classified as high risk. This difference suggests that ergonomic hazards may already exist before severe musculoskeletal complaints are reported by workers. Therefore, high ROSA scores should be considered an early warning for preventive intervention.

4. Discussion in relation to previous studies

The findings of this study are in line with previous office ergonomic studies which reported that computer-based workstations can increase ergonomic risk when the design of chairs, monitors, keyboards, and mouse placement does not support neutral posture. Sonne et al. developed the ROSA method to identify risk factors in office workstations and emphasized that high ROSA scores indicate the need for further assessment and corrective action [5]. In the present case study, all respondents obtained high ROSA scores, showing that workstation improvement is necessary.

The high complaint scores in the lower back, back, and neck are also consistent with previous findings on musculoskeletal disorders among office workers. Prolonged sitting, poor back support, and inappropriate workstation layout have been reported as common risk factors for discomfort in the spine and neck regions [1,3]. The NOC work environment observed in this study had similar characteristics, including long sitting duration, continuous screen monitoring, and limited posture variation.

The results are also comparable to studies that used both ROSA and body map-based questionnaires to assess ergonomic risks among computer users. These studies generally found that high workstation risk scores were associated with complaints in the neck, shoulders, back, lower back, arms, and wrists [2,6,7]. Therefore, the combined use of ROSA and NBM in this study provides a more complete understanding of the ergonomic problem. ROSA identifies the potential sources of risk, while NBM shows the body regions affected by the work condition.

In practical terms, these findings highlight the need for ergonomic intervention in NOC workstations. Improvements should prioritize adjustable chairs with adequate lumbar support and armrests, proper monitor height and viewing distance, and appropriate keyboard and mouse placement. In addition, work habit improvements such as regular stretching, posture variation, micro-breaks, and eye rest should be implemented to reduce static muscle loading and visual strain.

4.1. Practical implications

Based on the results, ergonomic improvement should focus on three main aspects: workstation facilities, working posture, and work habits. First, workstation facilities should be adjusted to support neutral posture. Adjustable ergonomic chairs should be provided to accommodate different body dimensions. Monitor placement should be adjusted so that the upper part of the screen is near eye level, while the viewing distance should remain comfortable. Keyboard and mouse placement should allow the elbows to remain close to the body and the wrists to remain straight.

Second, employees should be encouraged to maintain neutral working posture. The head and neck should remain aligned with the body, the back should be supported by the chair, the elbows should form an angle of approximately 90 degrees, and the feet should rest flat on the floor or on a footrest. These posture adjustments may reduce static muscle loading and improve comfort during prolonged computer-based work.

Third, healthy work habits should be promoted. Employees should be encouraged to take short breaks, perform stretching, and change posture periodically. The 20-20-20 rule may also be applied to reduce visual fatigue by asking employees to look at an object approximately 20 feet away for 20 seconds after every 20 minutes of screen use.

4.2. Study limitations

This study was conducted as a case study involving only eight respondents from one NOC work unit. Therefore, the findings cannot be generalized to all NOC employees or all office workers. The NBM method was based on subjective self-reported complaints, which may be influenced by individual perception of discomfort. In addition, the study used descriptive analysis and did not apply inferential statistical testing.

Despite these limitations, the combined use of ROSA and NBM provides useful practical information for identifying ergonomic risk factors and prioritizing workstation improvements. The findings may serve as a reference for similar computer-based work environments, especially those involving prolonged monitoring activities such as NOC operations.

5. Conclusion

This case study demonstrated that Network Operation Center (NOC) employees were exposed to high office ergonomic risks, as all respondents obtained final Rapid Office Strain Assessment (ROSA) scores ranging from 7 to 8, indicating the need for immediate corrective action. The Nordic Body Map (NBM) results further showed that musculoskeletal complaints were mainly concentrated in the lower back/waist, back, upper neck, and lower neck regions, which were closely associated with prolonged static sitting, inadequate chair support, improper monitor placement, and suboptimal keyboard and mouse positioning. The integration of ROSA and NBM provided a comprehensive understanding of both workstation-related risk factors and the body regions affected by computer-based monitoring work. These findings highlight the importance of improving workstation design through adjustable ergonomic chairs, proper monitor height and viewing distance, appropriate input device placement, regular stretching, micro-breaks, and ergonomic awareness programs. This study will benefit society by promoting healthier computer-based workplaces and provides a way forward for organizations to implement preventive ergonomic interventions to reduce musculoskeletal disorders and improve employee well-being and productivity.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there are no financial or non-financial conflicts of interest related to this study.

Statement of ethical approval

This study was conducted as a non-invasive observational ergonomic assessment in a workplace setting. The study did not involve clinical intervention, biological samples, or procedures that could harm the participants. Therefore, formal ethical approval was not required. Permission for data collection was obtained from the case company.

Statement of informed consent

All respondents were informed about the purpose of the study before data collection. Participation in the observation and questionnaire completion was voluntary. The respondents gave their consent to participate in this study.

Confidentiality statement

The identity of the case company and all respondents was anonymized to maintain confidentiality. The collected data were used only for academic and research purposes.

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