

IMMEDIATE AFFECT OF EXAMINATION REALATED STATIC POSTURE OVER MUSCULOSKELETAL SYSTEM

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ABSTRACT

Background: Examination periods require students to maintain prolonged static postures while sitting, reading, and writing continuously for extended durations. Such postural demands, combined with limited movement opportunities, may contribute to musculoskeletal discomfort and pain. However, limited evidence is available regarding the immediate musculoskeletal effects of examination-related static posture among college students.

Objective: To investigate the immediate effect of examination-related static posture on the musculoskeletal system and to identify the prevalence and characteristics of post-examination musculoskeletal discomfort among college students.

Methodology: An observational cross-sectional survey study was conducted among 350 college students aged 17–45 years who appeared for written examinations lasting at least one hour. Data were collected immediately after examinations using a self-structured questionnaire. Information regarding demographic characteristics, postural habits, ergonomic factors, examination-related stress, uniform-related discomfort, and musculoskeletal symptoms was obtained. Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS). Data were analysed using descriptive statistics and presented as frequencies and percentages.

Results: Among the participants, 88.6% reported sitting continuously for at least one hour during examinations, 80.9% leaned forward while writing, and 65.1% maintained prolonged neck flexion. Examination-related stress was reported by 80% of students. Immediate post-examination musculoskeletal pain was reported by 65.1% of participants. Pain most commonly developed after the examination (52.9%) and was predominantly intermittent in nature (74.6%). Pain disturbed concentration in 66.0% of participants and affected sleep in 57.4%. Although 82.3% reported symptom relief after rest, 54.0% stated that discomfort persisted even after reaching home. Additional observations indicated recurrent musculoskeletal symptoms among students who completed the questionnaire following multiple examination sessions.

Conclusion: Examination-related static posture is associated with a high prevalence of immediate musculoskeletal discomfort among college students. Prolonged continuous sitting, forward leaning posture while writing, sustained neck flexion, and examination-related stress emerged as the major contributing factors associated with post-examination musculoskeletal pain. The findings emphasize the importance of ergonomic awareness, proper sitting posture, regular postural adjustments, and appropriate examination seating arrangements to reduce musculoskeletal discomfort and promote students' well-being and academic performance.

Keywords: Examination, Static Posture, Musculoskeletal Pain, Ergonomics, Prolonged Sitting, Neck Flexion, Musculoskeletal Discomfort.

How to cite this article: Kumari J, Shrivastava M, Singroli A, Pawar A, Khan HP, Singh J, Shrivastava M. Immediate Affect of Examination Related Static Posture Over Musculoskeletal System. Int J Drug Deliv Technol. 2026;16(70s): 1019-1027. DOI: 10.25258/ijddt.16.70s.108

INTRODUCTION

Musculoskeletal disorders (MSDs) are among the most common health problems among all age groups including students and young adults. MSDs are characterized by pain, discomfort, stiffness, fatigue and functional limitations of muscles, joints, ligaments, tendons and other soft tissues. According to the World Health Organization, musculoskeletal conditions are among the leading causes of disability worldwide and they greatly affect an individual's daily activities and quality of life. Prolonged sitting, poor posture, repetitive writing activities and poor ergonomic conditions are major risk factors for the development of musculoskeletal symptoms among students.^[1]

Several studies have reported a high prevalence of musculoskeletal complaints among students especially in the neck, shoulders, upper back and lower back. Smith and Leggat state that prolonged academic engagement and extended static sitting postures are major contributors to musculoskeletal discomfort among students. Dianat and Karimi, similarly, found that students frequently reported musculoskeletal symptoms, often linked to prolonged sitting, poor posture, and poor ergonomic environments.^[2,3]

Static posture is holding a specific body position with minimal or no movement for a prolonged time. When sitting statically for an extended period of time, muscles must be active in order to maintain the position of body segments against gravity. Unlike dynamic activities static postures offer limited possibilities for muscular relaxation and recovery. Grandjean said that prolonged maintenance of static postures may result in muscle fatigue, diminished blood circulation, accumulation of metabolic waste products, and the onset of discomfort and pain.^[4]

Prolonged sitting is one of the most common postural exposures faced by students among other types of static postures. Callaghan and McGill (2015) concluded that sitting for prolonged periods increases compressive forces on spinal structures and changes normal spinal biomechanics. Sitting for long periods can also lead to decreased joint mobility and increased stress on passive tissues of the spine, which can cause neck pain, upper back pain and low back pain.^[5]

More recent evidence has also shown that prolonged sitting is associated with immediate musculoskeletal discomfort and increased muscular fatigue. Waongenngarm and colleagues discovered that the longer a person sits, the more uncomfortable various body regions become, especially the neck, shoulders and lower back. The study suggested that prolonged sitting may affect

musculoskeletal health even after a relatively short exposure time due to decreased movement and continuous muscle activation.^[6]

The specific conditions of the examination environment encourage prolonged static posture. During exams students are often required to sit for several hours continuously while reading, writing and maintaining a high degree of concentration. Opportunities to move are limited, and students may not change posture frequently since sitting is often required for examination purposes. Murphy and colleagues also reported a strong relationship between classroom and examination postures and musculoskeletal discomfort when students sit for an extended period.^[7]

One of the most common postural deviations observed during writing activities is a forward head posture. Students often lean their heads forward when reading questions and writing answers, causing excessive cervical flexion. With increased neck flexion, the effective load on the cervical spine increased significantly, Hansraj demonstrated. The greater the angle of neck flexion, the more stress is placed on the cervical muscles, ligaments and intervertebral structures, which can lead to neck pain, muscle fatigue and discomfort.^[8]

The association between neck pain and altered head posture has also been reported in the adolescent and young adult populations. Silva and colleagues found significant association between abnormal head posture and occurrence of neck pain and musculoskeletal symptoms. Thus, the prolonged maintenance of forward head posture may contribute to the development of discomfort during and immediately after examination sessions.^[9]

In addition to the cervical loading, the sustained sitting posture influences trunk muscle activity and spinal loading patterns. O'Sullivan et al. found significant effects of different sitting postures on trunk muscle activation and changes in spinal biomechanics. Unsupported sitting and prolonged trunk flexion increase the muscular demands on the thoracic and lumbar regions, which contributes to fatigue and discomfort in the upper and lower back.^[10]

Ergonomic factors also have a significant impact on the musculoskeletal comfort of students. The design of classroom furniture, including chair height, desk height, back support and space on the desk, directly influences sitting posture. Parcells and colleagues found that when the size of the student body did not match the classroom furniture, students would assume awkward postures that increased mechanical stress on the musculoskeletal

system.^[11]

Similarly, Castellucci et al. emphasized the contribution of inappropriate furniture dimensions to poor sitting posture and musculoskeletal complaints in students. Therefore, poor ergonomic support during prolonged academic activities may increase the risk of discomfort and pain during examination sessions.^[12]

Postural changes and movement are important strategies to reduce musculoskeletal stress while sitting. Vergara and Page found a strong association between comfort in sitting and posture and the ability to make postural adjustments. When students stay in a fixed position for a long period of time, it may cause more discomfort than those who change their position often.^[13]

Psychological factors may also be involved in the musculoskeletal symptoms experienced during examinations. The stress and anxiety related to exams can cause more muscle tension especially around the neck, shoulder and upper back area. Lundberg states that psychological stress can increase muscular activity and tension that can cause musculoskeletal discomfort and pain.^[14]

Several studies have examined the relationship between posture, ergonomics and musculoskeletal symptoms. Most research however has been focused on occupational settings or chronic musculoskeletal conditions. Briggs and colleagues suggested that it is important to identify posture-related musculoskeletal symptoms at an early stage, as prolonged exposure to poor posture may result in long-term musculoskeletal problems.^[15] However, limited studies have been conducted on the immediate musculoskeletal effects of examination-related static posture.

Therefore, considering the prolonged sitting position taken during the exams, the possible role of poor ergonomics and the lack of evidence about immediate post-examination musculoskeletal symptoms in students, the present study aims to investigate the immediate effect of exam-related static posture on the musculoskeletal system and to identify the prevalence, distribution and characteristics of musculoskeletal discomfort experienced after examinations.

METHODOLOGY

This observational cross-sectional survey study was conducted among college students appearing for written examinations in selected colleges and universities. The study aimed to investigate the immediate effect of exam-related static posture on the musculoskeletal system and to identify the prevalence and characteristics of musculoskeletal

discomfort experienced following examinations. A total of 350 participants, including both male and female students aged 17–45 years, were recruited using a convenience sampling technique. Students who appeared in written examinations and remained seated for at least one hour or more during the examination were considered eligible for participation. The inclusion criteria comprised students aged 17–45 years, both males and females, who were appearing in written examinations and remained seated throughout the examination for a minimum duration of one hour. Participants with a history of recent musculoskeletal injury, diagnosed neurological disorders affecting posture, balance, sensation, or movement, congenital musculoskeletal deformities affecting posture, previous spinal, upper limb or lower limb surgery, and those suffering from inflammatory or systemic musculoskeletal disorders such as rheumatological diseases and fibromyalgia were excluded from the study. Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS), an 11-point numerical scale ranging from 0 to 10, where 0 represented no pain, 1–3 represented mild pain, 4–6 represented moderate pain, and 7–10 represented severe pain. Data were collected using a self-structured questionnaire designed to obtain information regarding demographic characteristics, postural habits, ergonomic factors, examination-related stress, uniform-related discomfort factors, and immediate post-examination musculoskeletal pain. The collected data were compiled and analysed using descriptive statistical methods including frequency and percentage distribution.

PROCEDURE

The immediate effects of examination-related static posture on the musculoskeletal system were assessed using a self-structured questionnaire completed by participants immediately after their written examination. The questionnaire collected information regarding demographic characteristics, postural habits adopted during examinations, ergonomic factors, examination-related stress, uniform-related discomfort, and musculoskeletal symptoms experienced during or after the examination. Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS), an 11-point scale ranging from 0 to 10, where 0 represented no pain and 10 represented the worst imaginable pain. Participants experiencing discomfort were asked to rate their pain intensity and identify the body region affected. Postural habits during examinations were evaluated through questions related to prolonged sitting, neck flexion, forward leaning posture, writing behaviour, posture changes during examinations, and forearm support while writing. Ergonomic factors including chair support, desk height, and examination seating conditions were also assessed to determine their influence on musculoskeletal discomfort. Examination-related

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stress and uniform-related discomfort factors were evaluated using structured questions regarding perceived stress levels, restriction of movement due to uniform, uniform-related discomfort, and the contribution of footwear to physical discomfort during examinations. Musculoskeletal symptoms were further assessed by recording the timing of pain onset, nature of pain, duration of discomfort, persistence of symptoms, effect of pain on concentration and sleep, consultation-seeking behaviour, and factors affecting symptom severity. All responses were collected under standardized conditions with clear instructions provided to participants. The recorded data were stored electronically and subsequently exported to Microsoft Excel for coding, tabulation, and statistical analysis to ensure accuracy and consistency of findings.

RESULT

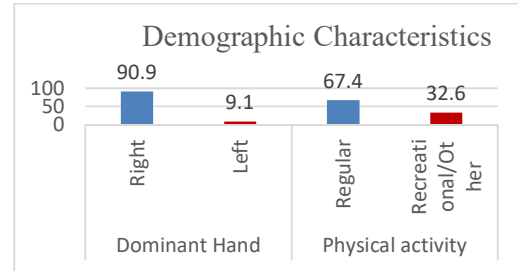
All statistical analyses were conducted using IBM SPSS Statistics version 26.0 and Microsoft Excel. As the present study was an observational cross-sectional survey study, descriptive statistics were used to summarize the collected data. The findings were expressed as frequencies (n) and percentages (%). The results were organized and presented in tabular and graphical formats to facilitate clear interpretation of the data. A total of 350 responses were collected from college students to investigate the immediate effect of examination related static posture on the musculoskeletal system. The results were analysed and presented under four domains: demographic characteristics, postural habits, ergonomic factors and stress during examination, uniform-related discomfort factors, and immediate post-examination musculoskeletal pain.

Table-1: Demographic Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Dominant Hand	Right	318	90.9
	Left	32	9.1
Physical Activity	Regular	236	67.4
	Recreational/Other	114	32.6

Interpretation

Among 350 participants, 90.9% were right-handed and 9.1% were left-handed. Most participants (67.4%) reported engaging in regular physical activity.



Graph-1: Distribution of Participants According to Demographic Characteristics

Table-2: Postural Habits, Ergonomic Factors and stress During Examination

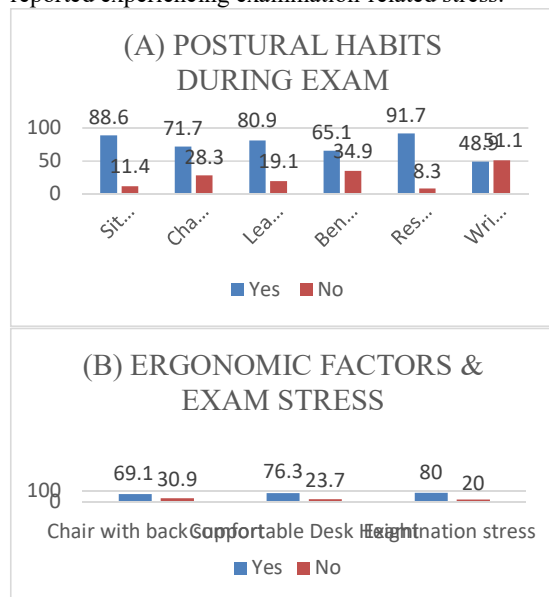
Postural Habits			
Variable		Frequency (n)	Percentage (%)
Sit continuously during exams	Yes	310	88.6
	No	40	11.4
Change posture during exams	Yes	251	71.7
	No	99	28.3
Lean forward while writing	Yes	283	80.9
	No	67	19.1
Bend neck downward for long periods	Yes	228	65.1
	No	122	34.9
Rest forearm on desk while writing	Yes	321	91.7
	No	29	8.3
Write continuously without stopping	Yes	171	48.9
	No	179	51.1
Ergonomic factors			
Variable	Category	Frequency (n)	Percentage (%)
Chair Type	With back	242	69.1

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	support		
	Without back support	108	30.9
Comfortable Desk Height	Yes	267	76.3
	No	83	23.7
Examination stress			
Response	Frequency (n)	Percentage (%)	
Yes	280	80	
No	70	20	

Interpretation

The majority of students reported sitting continuously for at least one hour during examinations (88.6%), leaning forward while writing (80.9%), and maintaining prolonged neck flexion (65.1%). Forearm support while writing was reported by 91.7% of participants. Approximately half of the participants (48.9%) reported writing continuously without taking breaks. Regarding ergonomic factors, 69.1% of participants used chairs with back support and 76.3% reported that the desk height was comfortable. More than half of the students (80%) reported experiencing examination-related stress.



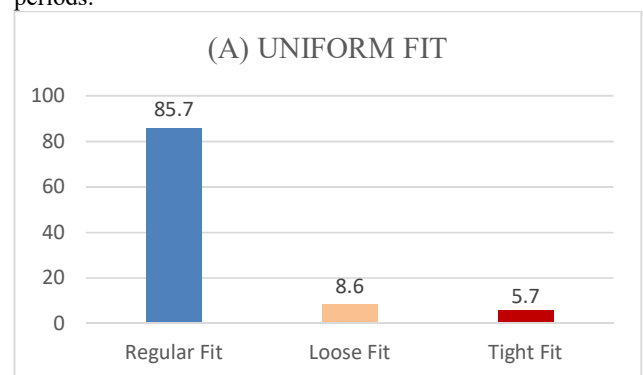
Graph-2: (A) Postural Habits Adopted During Examination (B) Ergonomic Factors and Examination-Related Stress Among Participants

Table-3: Uniform-Related Discomfort Factors (N=350)

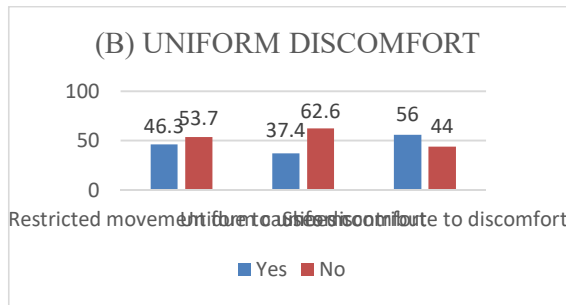
Uniform Fit			
Category		Frequency(n)	Percentage(%)
Regular Fit		300	85.7
Loose Fit		30	8.6
Tight Fit		20	5.7
Uniform Discomfort			
Variable		Frequency(n)	Percentage(%)
Restricted movement due to uniform	Yes	162	46.3
	No	188	53.7
Uniform causes discomfort	Yes	131	37.4
	No	219	62.6
Shoes contribute to discomfort	Yes	196	56.0
	No	154	44.0

Interpretation

Most students wore a regular-fit uniform (85.7%). Uniform-related discomfort was reported by 37.4% of participants, while 56% felt that footwear contributed to discomfort during examination periods.



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Graph-3: (A,B) Uniform-Related Discomfort Factors Among Participants

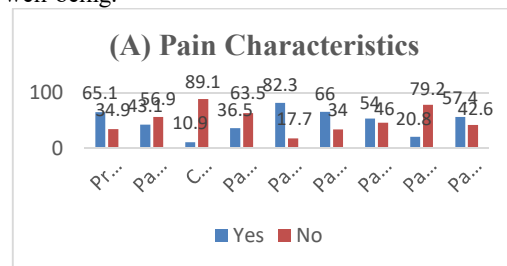
Table-4: Immediate Post-Exam Musculoskeletal Pain (N=350)

Variable	Response / Variable	Frequency (n)	Percentage (%)
Presence of pain	Yes	228	65.1
	No	122	34.9
Pain present after every exam	Yes	151	43.1
	No	199	56.9
Consultation for Pain	Yes	38	10.9
	No	312	89.1
Pain increases while writing	Yes	128	36.5
	No	222	63.5
Pain reduces after rest	Yes	288	82.3
	No	62	17.7
Pain disturbs concentration	Yes	231	66.0
	No	119	34.0
Pain continues after reaching home	Yes	189	54.0
	No	161	46.0
Pain remains till	Yes	73	20.8

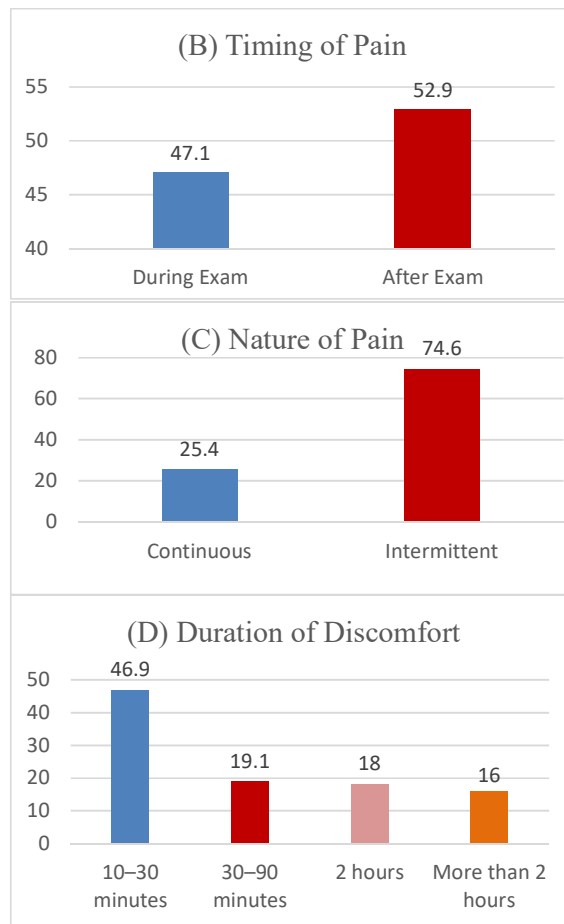
next morning	No	277	79.2
	Yes	201	57.4
Pain affects sleep	No	149	42.6
	Yes	201	57.4
Timing of Pain	During Exam	165	47.1
	After Exam	185	52.9
Nature of Pain	Continuous	89	25.4
	Intermittent	261	74.6
Duration of Discomfort	10–30 minutes	164	46.9
	30–90 minutes	67	19.1
	2 hours	63	18.0
	More than 2 hours	56	16.0

Interpretation

Out of 350 participants, 65.1% reported musculoskeletal pain immediately after examinations. Pain most commonly started after the examination (52.9%). Intermittent pain (74.6%) was more common than continuous pain (25.4%). Most students reported that pain reduced after rest (82.3%), while 54.0% stated that discomfort continued even after reaching home. Furthermore, 66.0% of participants reported that pain disturbed their concentration, and 57.4% reported that examination-related pain affected their sleep. These findings indicate that post-examination musculoskeletal discomfort is common and may negatively influence students' daily functioning and well-being.



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Graph-4: (A) Presence of Musculoskeletal Pain Following Examination, (B) Timing and Nature of Post-Examination Pain, (C) Impact of Pain on Concentration, Sleep and Daily Activities, (D) Duration of Post-Examination Musculoskeletal Discomfort

Observations from Repeated Examination Responses

During data screening, it was observed that the 350 responses included submissions from 151 participants (students). Among these participants, 59 students completed the questionnaire only once, whereas 92 students submitted responses following two or more examination sessions, contributing a total of 291 responses. An observational comparison suggested that students who responded after multiple examinations reported a relatively higher frequency of musculoskeletal pain, examination-related stress, and concentration disturbances compared to students who submitted the questionnaire only once.

Furthermore, repeated responses from the same participants indicated that musculoskeletal symptoms frequently recurred across examination sessions. Many students reported experiencing pain after multiple examinations, with symptoms often persisting after returning home and in some cases

affecting concentration and sleep. Although the present study was not designed to perform longitudinal follow-up, these observations suggest a possible cumulative effect of repeated examination-related static posture on the musculoskeletal system and highlight the need for further prospective research in this area.

DISCUSSION

The present study was conducted to investigate the immediate effect of examination-related static posture on the musculoskeletal system among college students. Examination periods require students to maintain prolonged sitting postures while reading and writing continuously with limited opportunities for movement. Such conditions increase mechanical loading on the cervical and thoracolumbar spine, shoulder, wrist etc., resulting in musculoskeletal discomfort and pain.

The findings revealed that most participants remained seated continuously for at least one hour during examinations (88.6%). Prolonged uninterrupted sitting reduces opportunities for muscle relaxation, decreases local blood circulation, and increases static loading on the spine and surrounding muscles. Previous studies by Murphy et al. and Straker et al. have similarly reported that prolonged sitting is associated with increased musculoskeletal discomfort among students.^[16,17]

A large proportion of participants (80.9%) reported leaning forward while writing and 65.1% maintained prolonged neck flexion during examinations. These postures increase the mechanical load on the cervical spine and require continuous activation of the neck and upper back muscles to support the head. Hansraj demonstrated that increasing neck flexion substantially increases cervical spine loading, predisposing individuals to neck pain, muscular fatigue, and postural discomfort.^[8]

Interestingly, although 91.7% of students reported resting their forearms on the desk while writing and 69.1% used chairs with back support, a high prevalence of musculoskeletal pain was still observed. This suggests that the presence of forearm support or back support alone may not be sufficient to prevent discomfort when students continue sitting for prolonged periods without adequate postural changes. Static loading, sustained muscle contraction, and reduced movement may outweigh the potential ergonomic benefits of supportive furniture.^[10,12]

Approximately 71.7% of participants reported changing their posture during examinations, whereas 28.3% remained in a fixed position throughout the examination. Frequent posture changes are known to redistribute mechanical stress, reduce muscular fatigue, and improve sitting comfort. Vergara and Page reported that regular

postural adjustments help minimize discomfort during prolonged sitting.[13] Similarly, although nearly half of the participants (48.9%) reported writing continuously without breaks, repetitive writing activity combined with static posture may further increase muscular fatigue of the upper limbs, shoulders, and neck.

Ergonomic factors also appeared to influence musculoskeletal health. While 76.3% of students considered the desk height comfortable, nearly one-fourth reported inadequate desk height, which may encourage awkward trunk and upper limb postures during writing. Previous studies have shown that inappropriate classroom furniture dimensions increase biomechanical stress and contribute to musculoskeletal complaints among students.^[11,12]

The present study also demonstrated that 80% of participants experienced examination-related stress. Psychological stress has been shown to increase muscle activity, particularly in the neck and shoulder regions, thereby aggravating musculoskeletal discomfort. Lundberg and Melin reported that mental stress contributes to increased muscular tension and pain.^[18]

Uniform-related factors were also evaluated. More than one-third of participants reported discomfort due to uniforms, while 56% believed that footwear contributed to physical discomfort. Although these factors are unlikely to be the primary cause of musculoskeletal symptoms, they may contribute to reduced comfort and altered posture during prolonged sitting and writing.^[19]

One of the most important findings of the study was that 65.1% of students experienced musculoskeletal pain immediately after examinations. Pain most commonly developed after the examination (52.9%), suggesting that muscular fatigue accumulates progressively during prolonged static posture. Similar findings were reported by Waongengarm et al., who demonstrated increasing discomfort and muscle fatigue with longer sitting duration.^[20]

Intermittent pain (74.6%) was more common than continuous pain, and 82.3% of students reported relief after rest. These findings indicate that the symptoms were mainly associated with temporary muscular fatigue and reversible postural stress rather than permanent structural damage.^[21]

The impact of examination-related discomfort extended beyond physical symptoms. Approximately 66% of participants reported that pain disturbed concentration, 57.4% reported sleep disturbance, and more than half experienced pain even after reaching home. These findings suggest that examination-related musculoskeletal discomfort may negatively influence students' academic performance, recovery, and overall well-being. Hakala et al. also reported associations between musculoskeletal pain, impaired

concentration, and sleep disturbances among students.^[22]

Overall, the findings indicate that prolonged sitting, forward leaning posture, sustained neck flexion, repetitive writing, inadequate movement, examination-related stress, and suboptimal ergonomic factors collectively contribute to immediate musculoskeletal discomfort among college students. These findings emphasize the importance of ergonomic awareness, postural education, regular movement strategies, and appropriate examination seating arrangements to reduce musculoskeletal symptoms during examination periods.

CONCLUSION

This study evaluated the immediate effect of examination-related static posture on the musculoskeletal system among college students. The findings revealed a high prevalence of musculoskeletal discomfort following examinations, with prolonged continuous sitting for at least one hour (88.6%), forward leaning posture while writing (80.9%), examination-related stress (80%), and sustained neck flexion (65.1%) emerging as the major contributing factors associated with immediate post-examination musculoskeletal discomfort. A majority of participants experienced musculoskeletal pain immediately after examinations, which in many cases persisted after returning home and affected concentration and sleep. Although most symptoms were relieved with rest, the findings suggest that prolonged static posture during examinations may contribute significantly to temporary musculoskeletal discomfort and reduced well-being. The results emphasize the importance of ergonomic awareness, proper sitting posture, regular postural adjustments, and appropriate examination seating arrangements to minimize examination-related musculoskeletal symptoms. These findings may help educational institutions develop preventive strategies to promote musculoskeletal health and improve students comfort and academic performance during examination periods.

FUTURE SCOPE OF THE STUDY

- Future interventional studies should evaluate the effectiveness of ergonomic education, postural exercises, stretching, and postural breaks in reducing examination-related musculoskeletal discomfort.
- Further research should investigate the association between examination duration, writing time, screen-based examinations, and musculoskeletal symptoms.
- Future studies should identify the prevalence, severity, and body-region distribution of musculoskeletal symptoms

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following examination-related static posture.

CONFLICT OF INTEREST: The authors declare that there are no conflicts of interest related to this research work. No financial, personal, or professional relationships have influenced the findings, analysis, or conclusions presented in this study.

FUNDING: This research paper was fully funded by the authors. No external financial support was received.

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