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Impact of ergonomic workstation interventions and scapular bracing on neck muscle performance, postural alignment, neck disability and work productivity in bankers with non-specific neck pain

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ABSTRACT

Background: Musculoskeletal disorders among bankers are linked to personal traits, prolonged working posture, repetitive tasks, and workstation design. Scapular bracing has been endorsed as an intervention for improving upper-body posture; however, evidence in symptomatic office workers is inadequate.

Objective: The purpose of this study was to compare the effects of an ergonomic workstation intervention alone versus a combined scapular brace plus ergonomic workstation intervention on forward head posture, rounded shoulder posture, neck disability, neck muscle performance, work productivity, and perceived stress in bankers with nonspecific neck pain.

Materials and Methods: Fifty bankers with non-specific neck pain were randomly assigned to one of two groups: ergonomic workstation intervention (control, N=25) or scapular brace plus ergonomic workstation intervention (experimental, N=25). Craniovertebral angle (CVA), forward shoulder angle (FSA), Neck Disability Index (NDI), neck muscle performance, work productivity, and Perceived Stress Scale (PSS) were all measured at baseline and four weeks later. The data were analysed with mixed-model repeated-measures ANOVA.

Results: Significant time × group interaction effects favoured the experimental group for CVA (p=0.005), FSA (p=0.001), NDI (p=0.017), neck muscle performance (p=0.004), and work productivity (p=0.003), indicating greater postural, functional, and productivity-related improvements as opposed to the control group. There were no significant between-group differences in perceived stress.

Conclusion: The addition of a scapular brace to an ergonomic workstation intervention may provide modest short-term benefits for posture, neck disability, neck muscle function, and job productivity in bankers suffering from non-specific neck pain, although perceived stress remains unaffected.

Introduction

Computer use has grown standard in modern settings, and extended visual display unit (VDU) use is strongly linked to neck and upper quadrant musculoskeletal issues.[1] Office jobs, such as banking, require extended sitting, repetitive upper-limb activities, and static postures, which increases the risk of neck and shoulder problems. Musculoskeletal issues among bank employees have continuously been connected to individual physical characteristics, working posture,

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repetitive actions, and workstation design.[2] Previous surveys have shown a significant prevalence of complaints in the neck, back, shoulders, and upper extremities among bank employees, emphasising the occupational burden of computer-related musculoskeletal conditions.[3]

Ergonomic workstation approaches are typically regarded as the key technique for controlling work-related musculoskeletal conditions in office settings. Adjustments to monitor height, chair support, keyboard and mouse position, and workstation layout are common interventions for reducing biomechanical strain on the cervical spine and upper extremities. Several studies have shown that ergonomic adjustments can minimise neck and shoulder pain, improve working posture, and, in certain situations, boost job efficiency among computer users.[4-6] However, evidence suggests that while ergonomics can improve the exterior work environment,[7] its impacts on sustained postural control and neuromuscular function may be limited, especially during prolonged computer work when postural drift and muscle fatigue are present.

Neck pain is frequently accompanied by neuromuscular dysfunction, which includes decreased endurance and poor activation of the deep cervical flexor muscles. Prolonged forward head posture, which is common among VDU operators, increases cervical spine loading and contributes to deep neck flexor weakness. Concurrently, changed scapular alignment and rounded shoulder posture are linked to alterations in axioscapular muscle activity, which may increase cervical loading and pain. The scapula and cervical spine are functionally and structurally interdependent, and abnormalities in scapular control have been reported in individuals with neck pain.[8-11]

While ergonomic interventions address workstation-related risk factors, they may not effectively alleviate postural and neuromuscular deficits during task performance. As a result, supplementary techniques that provide constant posture cueing and support throughout work activities may be necessary. Scapular bracing has been proposed as one such method, with the goal of influencing scapular alignment, improving proprioceptive feedback, and facilitating more optimum muscle activation. Scapular braces, as compared to taping, may be more suitable for long-term or daily use because they prevent skin irritation and can be worn during typical occupational work tasks.[12]

Previous research has shown that scapular bracing can impact scapular posture at rest and during low ranges of motion, potentially improving scapular muscle control.[13] Short-term studies in healthy people have showed moderate improvements in rounded shoulder posture and changes in muscle activation during typing tasks when using a scapular brace.[14] However, previous research has mostly focused on asymptomatic populations, athletes, and short-duration laboratory tasks. There is also a lack of research evaluating scapular bracing as a supplement to ergonomic workplace interventions in symptomatic office workers with extended computer exposure.

In addition to pain and physical dysfunction, job-related neck disorders are linked to decreased work productivity and sickness presenteeism, which occurs when individuals remain at work despite health issues that hinder performance.[15] Musculoskeletal pain can impair concentration, endurance, and task efficiency, making productivity a clinical and economic concern.[16] Therefore, interventions that lessen musculoskeletal strain and enhance postural stability while using a computer may help worker's productivity and perceived stress in ways that go beyond just reducing symptoms.

Accordingly, the current study aimed to compare the effectiveness of ergonomic workstation changes alone with ergonomic workstation adjustments combined with scapular bracing in symptomatic bankers with extended computer use. The study examined both between-group and within-group changes over time in work productivity, neck muscle performance, head and shoulder posture, neck disability, and perceived stress. It was hypothesised that the combined intervention would lead to higher improvements in these outcomes than ergonomic adjustments alone.

Materials and methods

Participants

Inclusion criteria: The study comprised 50 volunteers aged 20 to 40 years (Males=29, Females=21) from various banks working full time in Sahiwal division, Pakistan, who had neck pain for more than three months and complained of it at least once a week for the past twelve weeks.[17] The participants had no comorbidities and any regular medication use. In this study, neck pain was defined as non-specific neck pain that usually worsens as a result of poor posture at work and can be alleviated with postural adjustment.[17] Participants' Visual Analogue Scale (VAS) scores had to be mild (1-4) to moderate (4-6).[17] A craniovertebral angle of less than 48°,[18] forward shoulder angle greater than 22°,[19] the inability to generate a spike of at least 6 mmHg from the base pressure on the Biofeedback Pressure Unit and sustain the pressure generated for 10 seconds during cervical flexion were additional eligibility requirements.[20]

Exclusion criteria: Those who had their workstations ergonomically modified, had a Neck Disability Index (NDI) score greater than 28, were enrolled in a neck treatment program for neck pain within a year of the study's start, had undergone head surgery or trauma, or had previously experienced cancer, a systemic illness process, skin sensitivity, or infection were all excluded.[6] Participants with pregnancies, certain illnesses, or inflammatory conditions were also excluded.[6]

G*Power was used to calculate sample size. Independent t-test with two tails was considered. Minimal detectable change (MDC) for craniovertebral angle (1.1626) with the use of brace was employed to determine effect size from pilot study by Noordin NB *et al.*[21] SD set at 1.3 for both groups. Cohen's d was 0.89, test power was set at 0.80 and α=0.05. Total 42 participants were needed for this study and after including 20% dropout ratio 50 were enrolled.

Research personnel: One main researcher, a certified physiotherapist with a Doctor of Physical Therapy degree and is currently pursuing a PhD, with over three years of clinical experience. One assessor, a certified physiotherapist with a Doctor of Physical Therapy and PhD degree and more than three years of clinical experience, was blinded to group allocation.

A multistage convenience sampling strategy was used to recruit participants. Following random visits to commercial banks in the study area, bank staff members were briefed in person about the objectives and methods of the study. Enrolment was based on voluntary consent, and eligible bankers who indicated interest were then enrolled. After baseline characteristics (age, BMI score, daily computer use, gender) were recorded by assessor, participants were randomly assigned to one of two groups using the hat method: control group (N=25): ergonomic workstation intervention group, or experimental group (N=25): ergonomic workstation intervention with scapular brace group (Figure 1). Because of the nature of the interventions, the main researcher in charge of carrying out the workstation changes and scapular bracing was not blinded to group allocation. However, the outcome assessor was blinded to group assignment and did not participate in intervention delivery, lowering the possibility of assessment bias. Table 1 shows demographics of participants.

To protect participants' privacy, each was allocated a unique number that was used on all documents, data collection forms, and assessment forms. Following recruitment from all banks, participants were pooled into a single sample and randomly assigned to either the experimental or control groups using a simple random draw process, regardless of bank affiliation. This method was chosen to give the same probability of allocation for all participants. All eligible volunteers from each bank were assigned unique identification numbers, which were then placed in sealed, opaque envelopes. An impartial individual who was not engaged in recruitment or intervention delivery thoroughly mixed these envelopes and randomly assigned them to each group in alternating order. The participants were then informed, either in person or over the phone, of their random selection and group assignment. The main researcher enrolled the study participants. Subjects blinding was also impossible because some participants with braces and without braces were present in the same bank. Randomisation was done at the individual participant level, with no stratification by bank. No blocking method was used. A basic randomisation process was used to allocate groups, resulting in nearly balanced group sizes by chance.

Ethical approval letter was obtained from The Research Ethics Review Committee for Research Involving Human Research Participants, Chulalongkorn University (COA. 108/67) Dated: 15 May 2024. Written consent forms were signed by the participants before start of study explaining them the procedure and the potential use of their data in publication keeping their identities confidential.

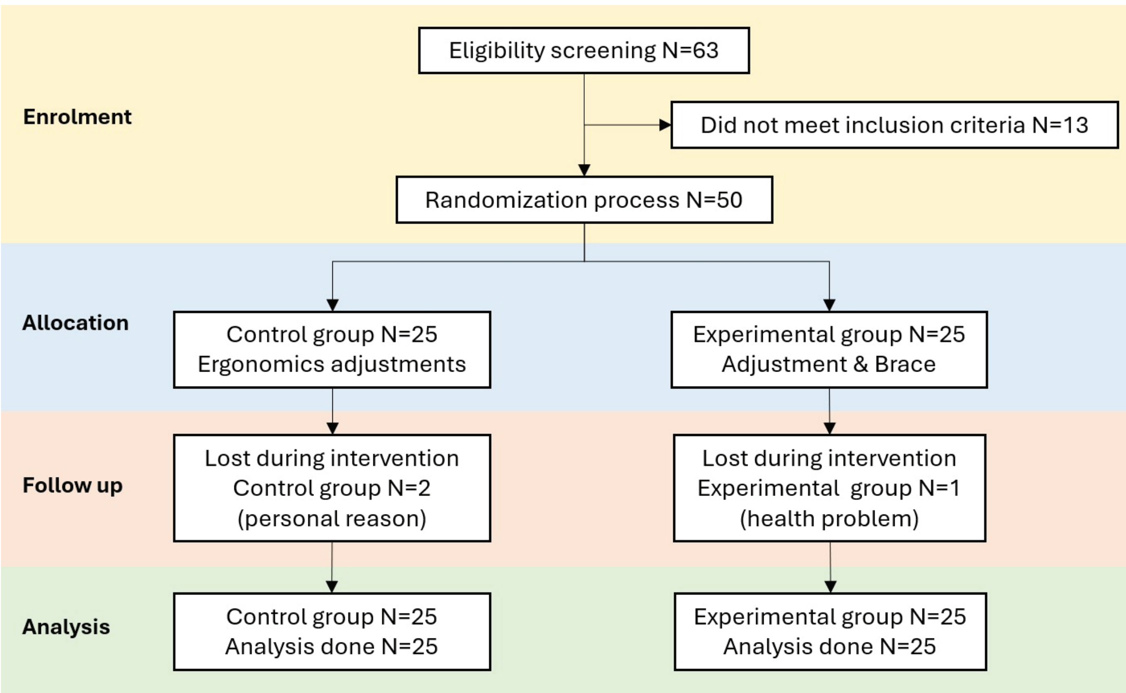

Figure 1. *CONSORT Diagram*

Interventions

Before the study started, ergonomic workstation adjustments were given to all participants based on the Canadian Standards Association's Office Ergonomics Guidelines (CSA-Z412-00) that Smith *et al.*[6] had previously employed. The adjustments were made by the main researcher and were tailored to each participant's anthropometric features and workstation configuration, while remaining consistent with the standardised guideline. Table 1 lists the modifications that participants required.

Experimental group

The 8-figure scapular brace ((Energizing Posture Support, Bell Plus company, Model Dr. Magico, Number 11180022)) was applied by the main researcher in accordance with the manufacturer's instructions see Figure 2.

Table 1. Workstation adjustments needed.

Parameters	Control N=25	Experimental N=25	Adjustments given
Chair			
• Regassing	5	7	Chair seat re-gassed
• Lumbar support	7	7	Lumbar cushion
• Armrest height correction	6	8	Armrest height corrected
• 5-8 degrees tilt	22	21	Tilted 5-8 degrees
• Footrest	3	2	Footrest provided
Monitor			
• Monitor raise	17	11	Monitor raised
• Monitor lowering	7	10	Monitor lowered
Workstation accessories			
• Flat keyboard	2	2	Flat keyboard provided
• Wrist-rest	3	5	Wrist-rest provided
• Documents holder	13	7	Document holder provided
• Headphones	2	5	Headphones provided

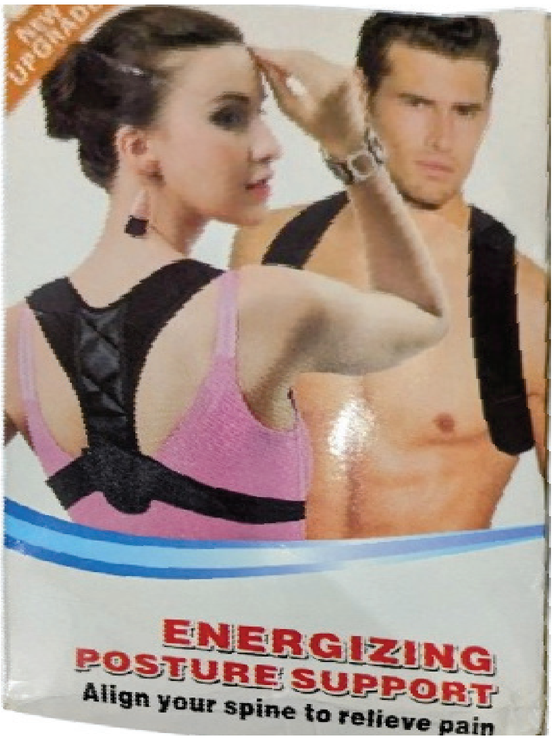

Figure 2. *The 8-figure scapular brace used in this study.*

The adjustable straps allow for common application of the brace by the recruited individuals in the experimental group. The brace was strapped over regular clothes on the upper back. Each subject received training on how to put on and remove the brace. It was advised that subjects wear the brace for six hours per day, with a minimum of 30 minutes in continuation during office hours, for 4 weeks, as previously implemented by Bankhele *et al.*[22] The 4-week intervention time was chosen in order to assess the interventions' immediate effects in real-world work environments. Although prior ergonomic studies have employed longer intervention periods, short-term results are still clinically relevant, especially for early symptom alleviation and feasibility assessment. Rest breaks were optional, although participants were instructed to remove the brace while standing or walking and avoid wearing on holidays. This instruction was given to reduce discomfort, avoid dependency, and limit intervention to task-specific postural support during extended desk work. However, the objective adherence metrics like wear-time sensors and daily logs were not employed. A single adjustable model of brace with adjustable straps and suitable padding was used see Figure 3.

Figure 3. *Participant wearing the scapular brace.*

The main researcher visited the participants in banks twice a week to ensure compliance and note down any complaints or issues occurred. Also, the participants were reminded of the scapular brace everyday via a phone call to the bank.

Assessment

An assessor blinded to group allocation conducted evaluations at baseline and four weeks post-intervention, when the study was completed and participants were not wearing scapular braces. Participants' VAS scores were used to measure pain, and these scores were only taken at baseline because they were a requirement for inclusion. The 10cm VAS was used by participants to report their level of pain.

Primary outcome measure (postural)

Participants' craniovertebral angles (CVA) were measured for the forward head assessment. CVA was the primary outcome measure. CVA is the point where a line from the skin above the C7 spinous process to the midline of the tragus of the ear intersects a horizontal line with the C7 spinous process (Figure 4).[23]

Secondary outcome measure (postural), forward shoulder angle FSA was measured for rounded shoulder assessment. FSA is a point where a line connecting acromion and C7 spinous processes meet a vertical line crossing C7 process see Figure 5.

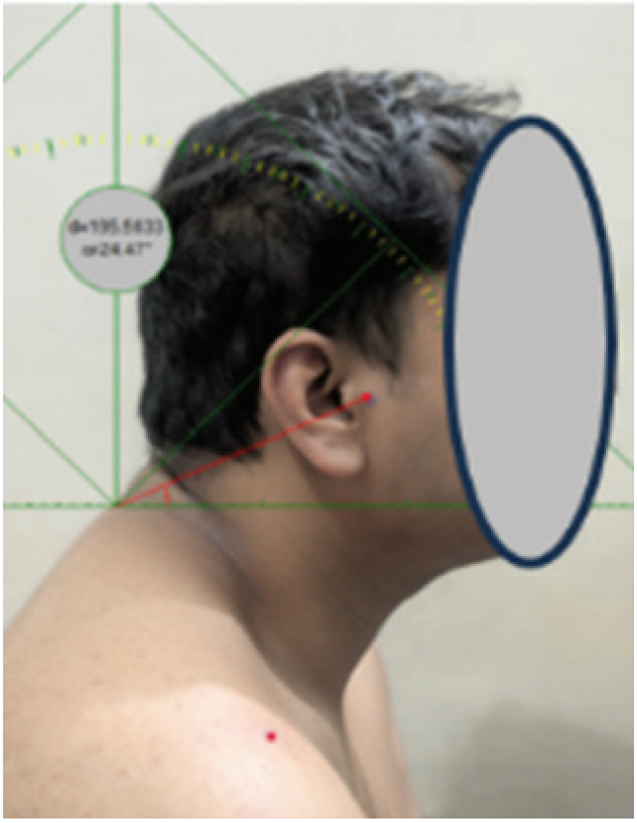

Figure 4. *CVA measured with Marcus Bader ruler program.*
(The red line connects the tragus of ear and C7 spinous process.)

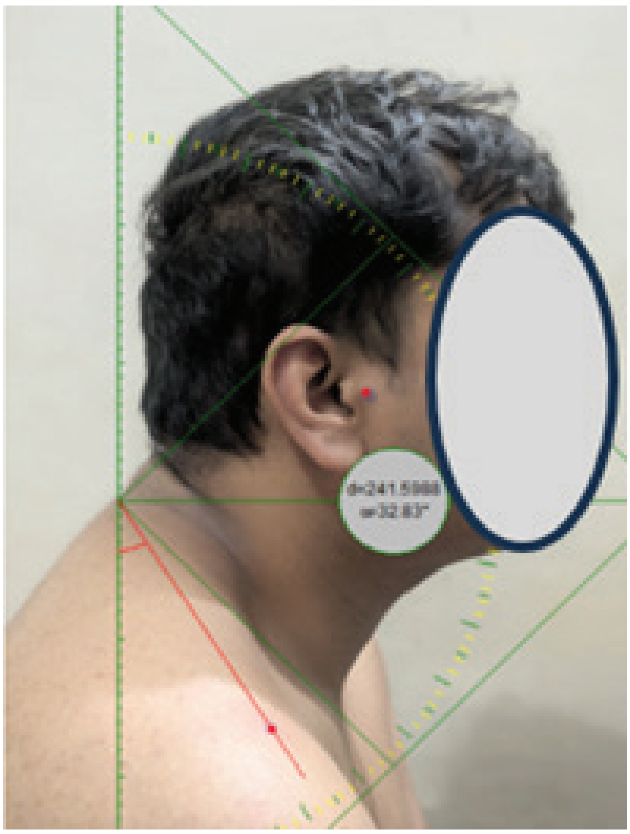

Figure 5. *FSA measured with Marcus Bader ruler program.*
(The red line connects the C7 spinous process and tip of acromion process.)

CVA and FSA were measured by photography technique in sitting position. Pictures were taken in lateral view in an empty room usually the common or break room in most of the banks, especially for the privacy of female participants. Permission from the bank manager was always taken beforehand. Prior to taking photograph in a neutral position, the participant was instructed to fully extend and flex their neck three times and then rest in the most balanced posture that feel comfortable. Pixel 6a camera was mounted on a tripod. The lens on the camera was adjusted to the level with the external auditory meatus by modifying the camera tripod's height. The camera was 1.5m away from the participant. Participant was sitting in a neutral position looking straight with back supported, hands on the thighs and feet flat. They were asked to concentrate visually on a point just ahead on the room's wall. The assessor confirmed the visual focal point when the individual had reached a comfortable seating position. This reduced the inclination of the neck to flex or extend while keeping a comfortable head position. Finally, a lateral view of each subject was photographed. One photograph per posture was obtained.[24]

Marcus Bader's MB Ruler program was used to determine the angles from the photos. After placing the ruler over the photos, the measurements were noted.[25]

Secondary outcome measure (functional)

The performance of the neck muscles was evaluated using Biofeedback Pressure Unit (BPU) readings. Participants' deep neck flexor function was evaluated using a Pressure Biofeedback Unit (BPU) while supine lying. The pressure cuff was put sub occipitally and inflated to 20 mmHg. Participants were advised to do a modest cranio-cervical flexion. DNF strength (pressure performance) was quantified as the highest-pressure level (mmHg) that the individual could achieve and sustain for 10 seconds without substitution. DNF endurance was quantified as the greatest duration (in seconds) during which the desired pressure level could be maintained without tiredness or loss of pressure control. No repetitions were averaged; only the best attempt was retained for analysis.[20]
Secondary outcome measures (self-reported):

Secondary outcome measure (self-report)

NDI was used to measure neck disability. The NDI is a self-assessment tool for the specific functional status of patients with neck pain, consisting of ten elements: pain, personal care, lifting, reading, headache, concentration, work, driving, sleeping, and leisure. Each part is scored from 0 to 5, with 0 being "painless" and 5 being "the worst pain imaginable".[26]

Work Productivity and Activity Impairment-Specific Health Problem (WPAI-SHP) questionnaire was used to measure work productivity in terms of overall work impairment (absenteeism+presenteeism). It is a validated questionnaire to evaluate work productivity loss, absenteeism, presenteeism, and activity impairment due to specific health problem over the previous 7 days.[27] The specific health problem was neck pain in this study. The WPAI:SHP results are reported as percentages of impairment, with higher numbers indicating greater impairment and lower productivity.[28]

Perceived Stress Scale questionnaire comprising of 10 questions was used to assess the stress factor in the participants. It helps participants to compare their global perceptions of stress with the epidemiology of disease.[29] No stress-specific intervention was used, as perceived stress was added as a secondary exploratory outcome to see if postural correction and reduction in musculoskeletal strain related with intervention would be accompanied by changes in total perceived stress.

Pain intensity (VAS) was measured at baseline to characterise symptom severity and confirm eligibility; however, it was not evaluated after intervention because the trial was primarily meant to investigate postural and functional changes rather than pain reduction.

Prior to data collection, the assessor was given specific training in standardised posture assessment, anatomical landmark identification, and pressure biofeedback unit testing, all in accordance with previously published protocols. To guarantee consistency, all measures were taken with the same equipment, standardised positioning, and established protocols throughout the investigation. Formal intra- or inter-rater reliability testing was not performed in this study. Previous studies have shown that the tools and processes employed have good to excellent intra- and inter-rater reliability.[8, 30-32]

All raw data, photos, and digital measurements were securely saved on password protected institutional software that could only be accessed by the assessor. Before the analysis, participant identifiers were anonymised. The data were stored in conformity with institutional research data management rules.

Statistical analysis

Data analysis was conducted using IBM SPSS Statistics version 29.0 (IBM Corporation, Armonk, NY, USA). The participant's demographic characteristics were analysed using the chi-square test for gender and job title and the independent t-test for age, BMI, and daily PC usage hours. The Shapiro-Wilk test was employed to evaluate the numerical data's normal distribution. The overall effects of time (baseline and at 4 weeks), groups (control and experimental), and time×group interaction were examined using mixed ANOVA. The Bonferroni post hoc test was used for paired comparisons. For every test, the significance threshold was set at 0.05. Baseline observation carried forward (BCOF) was used as intention-to-treat technique for dropouts.

Results

Fifty bankers were equally divided into two groups. There were no significant differences between the groups in terms of age, gender, BMI, daily computer use, or job title (*p*=0.194, *p*=0.774, *p*=0.753, *p*=0.881 and *p*=0.344 respectively). Table 2 shows demographics of participants.

Table 3 illustrates descriptive statistics and pairwise comparisons for every outcome measure. At baseline or at four weeks, no outcome measure showed a significant between group difference.

Table 3. The values of NDI, CVA, FSA, WPAI-SHP, BPU pressure, BPU seconds held and PSS at baseline and at 4th week.

Outcome measures	Control group (N=25)		Experimental group (N=25)	
	At baseline Mean±SD	At 4th week Mean±SD	At baseline Mean±SD	At 4th week Mean±SD
CVA (degrees)	35.68±2.19	35.74±2.16	35.22±2.21	35.58±2.20†
Neck disability index	16.32±2.62	16.20±2.90	18±2.51	16.96±2.11†
Forward shoulder angle	26.20±1.71	26.13±1.70	26.58±1.64	25.86±1.50†
BPU pressure (mmHg)	24.84±0.94	24.88±0.88	24.68±0.94	25.04±0.93†
BPU (seconds)	6.88±0.88	6.76±1.33	6.96±1.05	7.2±1.11
WPAI-SHP	36.96±6.96	36.78±6.77	40.86±7.79	36.72±5.55†
PSS	17.92±3.34	17.68±3.14	19.28±3.11	19.04±3.00

Note: *†significant difference from baseline, CVA: craniovertebral angle, FSA: forward shoulder angle, BPU: biofeedback pressure unit, WPAI-SHP: work productivity and activity impairment-specific health problem, PSS: perceived stress score.*

Table 4. Time, group and interaction main effects of all outcome measures.

Outcome measures	Main effect (group)			Main effect (Time)			Main effect (Time*group)		
	F(df)	ηp^2	*p* value	F(df)	ηp^2	*p* value	F(df)	ηp^2	*p* value
CVA (degrees)	0.254(1)	0.005	0.617	17.34(1)	0.265	**0.001**	8.45(1)	0.150	**0.005**
NDI	3.05(1)	0.060	0.087	9.65(1)	0.167	**0.003**	6.07(1)	0.112	**0.017**
FSA (degrees)	0.013(1)	0.000	0.911	48.5(1)	0.503	**0.001**	33.27(1)	0.409	**0.001**
BPU pressure (mmHg)	0.000(1)	0.000	1.0	14.28(1)	0.229	**0.001**	9.14(1)	0.160	**0.004**
BPU (seconds)	1.385(1)	0.028	0.245	0.072(1)	0.002	0.789	0.65(1)	0.013	0.423
WPAI-SHP (overall impairment)	1.112(1)	0.023	0.297	11.60(1)	0.195	**0.001**	9.79(1)	0.169	**0.003**
PSS	2.40(1)	0.048	0.127	2.06(1)	0.041	0.158	0.000(1)	0.000	1.0

Note: *df: degrees of freedom, ηp^2: partial eta squared, CVA: craniovertebral angle, NDI: neck disability index, FSA: forward shoulder angle, BPU: biofeedback pressure unit, WPAI-SHP: work productivity and activity impairment-specific health problem, PSS: perceived stress score, bold values are significant.*

Primary outcome measure (CVA)

The craniovertebral angle (CVA) showed a significant group×time interaction (F=8.45, *p*=0.005, partial η^2=0.150). From 35.22°±2.21 to 35.58°±2.20, the experimental group showed an increase, with a mean change of 0.36° (95% CI: 0.18° to 0.54°). The control group showed no apparent change (Table 3 and Table 4).

Secondary outcome measures

A mixed ANOVA indicated a significant group×time interaction for neck disability (F=6.07, *p*=0.017, partial η^2=0.112), showing differences in change over time among groups. The experimental group's NDI scores decreased from 18.00±2.51 at baseline to 16.96±2.11 post-intervention, representing a mean drop of -1.04 points (95% CI: -1.58 to -0.50). The control group showed no significant difference (16.32±2.62 to 16.20±2.90)(Table 3 and Table 4).

A significant interaction effect was observed for the forward shoulder angle (FSA) (F=33.27, *p*<0.001, partial η^2=0.409). While the control group showed little change, the experimental group showed a decrease from 26.58°±1.64 to 25.86°±1.50, or a mean change of -0.72° (95% CI:-0.95° to -0.49°) (Table 3 and Table 4).

Biofeedback pressure unit (BPU) pressure measurements of deep neck flexor activation revealed a significant group×time interaction (F=9.14, *p*=0.004, partial η^2=0.160). The experimental group's mean improvement was 0.36 mmHg (95% CI: 0.19 to 0.53), rising from 24.68±0.94 mmHg to 25.04±0.93 mmHg. The control group showed no discernible change (Table 3 and Table 4).

There was no significant group×time interaction for endurance (F=0.65, p=0.423). Over time, both groups showed modest and insignificant improvements. (Table 3 and Table 4).

A significant group×time interaction was observed in work productivity as measured by the WPAI-SHP (F=9.79, p=0.003, partial η^2=0.169). Overall work impairment decreased in the experimental group from 40.86±7.79 to 36.72±5.55, with a mean change of -4.14 points (95% CI: -6.10 to -2.18). The control group showed no apparent change (Table 3 and Table 4).

Experimental group had higher baseline stress scores. There was no significant group×time interaction in perceived stress, and both groups showed minimal change during the intervention period (Table 3 and Table 4).

Discussion

This study examined the short-term effects of ergonomic workstation modifications alone and in combination with scapular bracing on neck disability, posture, deep neck flexor performance, perceived stress, and job productivity in bankers who had non-specific neck pain. The study found that adding a scapular brace to ergonomic adjustments led to significant group×time interactions for several outcomes. However, the magnitude of change was modest, and findings should be interpreted as short-term within-group improvements rather than clear clinical superiority over ergonomics alone.

The neck disability index (NDI) showed a significant group × time interaction (F=6.07, p=0.017, ηp^2=0.112). Over four weeks, the experimental group's NDI scores dropped from 18.0±2.51 to 16.96±2.11, a reduction of about 1.0 point on average. Although statistically significant, this shift falls below the generally quoted minimal clinically meaningful difference levels for the NDI, implying a minor but noticeable functional improvement rather than a clinically significant change. There was no significant change in the control group.

Postural variables exhibited comparable trends. There was a significant group × time interaction for craniovertebral angle (CVA) (F=8.45, p=0.005, ηp^2=0.150). The experimental group exhibited an increase in CVA from 35.22°±2.21 to 35.58°±2.20, indicating a slight reduction in forward head posture. The experimental group improved their forward shoulder angle (FSA) from 26.58°±1.64 to 25.86°±1.50, with a significant interaction effect (F=33.27, p=0.001, ηp^2=0.409). While these variations in posture were statistically significant, their therapeutic implications should be evaluated cautiously, as very minor angular changes may not result in significant biomechanical or functional gains in the short term.

The observed postural improvements are consistent with biomechanical literature that links prolonged slumped sitting postures to higher cervical extensor loading, forward head posture, and rounded shoulders, all of which lead to neck pain and muscle fatigue.[33,34] Although scapular kinematics were not directly examined, the postural changes reported in this study may be attributed to increased postural awareness or external cueing provided by the brace.[12,22] This perspective is supported by previous work, but it remains theoretical because neuromuscular processes were not assessed in the current investigation.

Deep neck flexor performance exhibited varied changes. Biofeedback pressure unit (BPU) data revealed a significant group × time interaction for pressure (F=9.14, p=0.004, ηp^2=0.160). The experimental group showed a rise from 24.68±0.94 mmHg to 25.04±0.93 mmHg, indicating better activation or neuromuscular control. In contrast, endurance, defined as the duration of sustained contraction in seconds, did not show a significant interaction effect (F=0.65, p=0.423). The experimental group showed a tiny numerical rise from 6.96±1.05 seconds to 7.20±1.11 seconds, which was neither statistically nor clinically significant.

This distinction between power and endurance is consistent with the cervical motor control literature. Activation improvements can be achieved by improved alignment and lower inhibitory loads, but endurance adaptations often necessitate extended, low-load, task-specific training.[8,35] The lack of an organised deep neck flexor training program, along with the short intervention duration, most likely hampered endurance-related improvements. Furthermore, external postural support may have lowered muscle demand, so dampening the stimulus required for endurance development.

The WPAI-SHP revealed a significant group×time interaction on work productivity (F=9.79, p=0.003, ηp^2=0.169). The experimental group improved from 40.86±7.79 to 36.72±5.55, showing a modest reduction in perceived overall impairment. While statistically significant, productivity was assessed solely through self-reported measures, which coul d be influenced by response bias and subjective perception. Furthermore, no objective productivity measurements were provided, therefore these findings should be viewed as preliminary. To our knowledge, this is one of the first studies to look at perceived work productivity in bankers using a scapular brace; nonetheless, stronger results require objective metrics and a longer follow-up period.

There was no significant difference in perceived stress scores between the two groups, and no group×time interaction was observed. This shows that participants' work stress was more likely caused by psychological and organisational variables than by physical symptoms alone. Because no intervention addressing workplace stressors was included, the lack of change is consistent with previous research associating stress primarily to job demand, control, and organisational support.[36]

Within four weeks, the ergonomic workstation intervention did not result in significant improvements across all outcomes. This contrasts with prior research indicating effects following longer intervention periods, often eight weeks or more.[4] The absence of improvement in the control group demonstrates that short-term ergonomic changes may not be adequate to produce meaningful postural, functional, or neuromuscular adaptations. One objective of the present study was to discover whether ergonomic changes alone create short-term effects; the data imply that longer exposure may be required.

Limitation

While interpreting these results, a number of limitations should be taken into account. Despite the use of random allocation, no significant between-group differences were found, limiting inferences on the superiority of scapular bracing versus ergonomic workstation modifications. Simple randomisation using sealed envelopes was used, which may result in less allocation concealment than computer-generated approaches. The four-week intervention period may not have been long enough to capture the full effect of ergonomic changes documented in longer-term research. Participant blinding was not possible; however, outcome assessments were performed after the brace was removed to maintain assessor blindness. Regardless, performance and detection bias because of main researcher cannot be eliminated. Adherence to intervention was promoted but not objectively monitored, creating ambiguity about intervention fidelity. Several outcomes were based on self-reported questionnaires, which may be prone to recall and response bias, and pain intensity was only measured at baseline, preventing study of pain changes over time.
Postural measurements were taken from single standardised pictures without any systematic intra- or inter-rater reliability testing, which could have introduced measurement error despite assessor training. And the lack of long-term follow-up and recruiting in a specific geographic region may restrict the observed effects' generalisability and durability.

Conclusion

This study examined the short-term impact of ergonomic workstation changes with and without scapular bracing in bankers complaining of non-specific neck pain. Over a four-week period, the use of a scapular brace resulted in modest short-term within-group improvements in postural alignment, neck disability, deep neck flexor activation, and work productivity. However, these benefits did not clearly outperform ergonomic intervention alone, and the magnitude of change was modest.

As a result, scapular bracing may be used in conjunction with ergonomic workstation adjustments to provide short-term postural support, rather than as a stand-alone or superior intervention. Future research should look at longer intervention periods, tailored cervical exercise programs, and follow-up examinations to further understand the role of scapular bracing in occupational neck pain management.

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Conflict of interest

No conflict of interest is present among authors.

CRediT authorship contribution statement

Montakarn Chaikumarn contributed to the title, methodology formulation, outcome measure selection and critical review of the research; **Muhammad Awais Tassawar** contributed to conception, design, the interventions implementation, interpretation and manuscript formation; **Soyba Nazir** contributed to data acquisition and statistical analysis.

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