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Original Article

Investigating the Association of Blackboard Teaching with Scapular Dyskinesia and Shoulder Pain Among School Teachers in Karachi, Pakistan

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ABSTRACT

Background: Musculoskeletal disorders (MSDs) represent a significant occupational health burden globally, with teachers frequently reporting shoulder pain due to repetitive overhead tasks such as blackboard writing. Scapular dyskinesia, characterized by altered scapular positioning, is increasingly recognized as a contributor to shoulder dysfunction, yet data from Pakistan remain limited. Objective: To investigate the association between blackboard teaching and the prevalence of scapular dyskinesia and shoulder pain among female school teachers in Karachi, Pakistan. Methods: A cross-sectional observational study was conducted over six months in six schools in Karachi, enrolling 56 female teachers aged 20–45 years with at least two years of teaching experience and a minimum of two hours per week of blackboard instruction. Data collection included the Shoulder Pain and Disability Index (SPADI) for assessing pain and disability, and the Lateral Scapular Slide Test (LSST) for measuring scapular asymmetry. Ordinal logistic regression was used to identify predictors of pain severity, adjusting for age, teaching experience, and shoulder pain duration. Results: Moderate shoulder pain was prevalent (mean SPADI pain at worst: 3.70, SD = 2.87). Greater scapular asymmetry, particularly >1 cm, significantly predicted higher pain severity (OR = 0.28, p = 0.025). Disability burden increased with pain chronicity and was highest among teachers with greater asymmetry. Age and teaching experience were not significant predictors. Conclusion: Blackboard teaching contributes to shoulder pain and scapular dyskinesia among female teachers in Karachi, with scapular asymmetry independently associated with higher disability burden. Ergonomic interventions and targeted rehabilitation are warranted to reduce occupational MSD risk.

Keywords: Blackboard teaching, scapular dyskinesia, shoulder pain, musculoskeletal disorders, occupational health, teachers, Karachi, SPADI, LSST

INTRODUCTION

Musculoskeletal disorders (MSDs) are recognized globally as a significant occupational health burden, with teachers emerging as a high-risk group due to the physical demands of their work, particularly prolonged static postures and repetitive overhead arm movements during blackboard teaching. In many countries, women increasingly comprise the teaching workforce, making it imperative to address gender-specific occupational risks (1). According to the National Occupational Research Agenda (NORA) in the United States, MSDs at work represent a substantial proportion of job-related illness costs, estimated between $13 and $54 billion annually, and constitute a major cause of early retirement and reduced workforce productivity among teachers (2). Research across various countries has revealed a strikingly wide prevalence of MSDs among teachers, ranging from 23.7% to 95.1%, with neck, shoulder, and lower back pain being most commonly reported (3). Specifically, shoulder pain prevalence exhibits substantial international variability, from as low as 15% in Egypt to 83.1% in South Africa (4-10), influenced by differences in educational systems, ergonomics, work organization, and socio-cultural contexts. In China, the prevalence of neck and shoulder pain among teachers was reported at 48.7% (5), while rates in Saudi Arabia, Japan, Malaysia, Hong Kong, Nigeria, and India ranged from 35.4% to 73.4% (4,6-10). Notably, a lower prevalence has been reported in Lahore, Pakistan (30.6%) (11), but data remain sparse overall for Pakistan, particularly urban centers such as Karachi.

The shoulder joint's mobility, while essential for functional upper limb tasks, renders it vulnerable to repetitive strain injuries (12). Teachers, especially in low- and middle-income countries (LMICs), are subject to prolonged periods of blackboard writing, often performed under ergonomically suboptimal conditions that exacerbate the risk of scapular dyskinesia and shoulder pain (13). Scapular dyskinesia, characterized by altered scapular positioning and motion, disrupts normal shoulder kinematics and has been implicated in a wide array of shoulder pathologies (14,15). Studies suggest that scapular dyskinesia increases the risk of developing shoulder pain by 43% in populations exposed to repetitive overhead tasks (16), highlighting its clinical relevance as an early marker of shoulder dysfunction. The abnormal movement patterns associated with scapular dyskinesia, including early scapular elevation and impaired rotation, contribute

to reduced glenohumeral stability, placing additional mechanical stress on peri-scapular musculature and the rotator cuff during overhead activities (17,18). Teachers report a high burden of musculoskeletal symptoms, with shoulder pain affecting 73.4%, neck pain 68.9%, and lower back pain 59.2% in some studies (8,19). These symptoms diminish teachers' quality of life, increase sick leave and absenteeism, and in severe cases lead to disability and early retirement, thereby imposing significant societal and economic costs (20). Despite this evidence, Pakistan remains underrepresented in the global research landscape on work-related MSDs in teachers. Existing studies in Pakistan have largely been confined to Lahore, with limited focus on shoulder biomechanics or scapular dyskinesia, and none addressing teachers in Karachi—the country's largest urban center with distinctive school environments and teaching practices (11). This lack of localized data restricts the ability to develop targeted ergonomic interventions and workplace health policies suited to the specific risks encountered by female teachers in Karachi. Teachers in this context often work with non-adjustable blackboards, endure large student-to-teacher ratios, and face constrained institutional support for occupational health, all factors that may compound their risk of developing shoulder pain and related dysfunction.

This study aims to address this critical knowledge gap by examining the association between blackboard teaching and the prevalence of scapular dyskinesia and shoulder pain among female school teachers in Karachi, Pakistan. By quantifying the prevalence of these conditions and identifying their relationship with teaching practices, the findings will inform ergonomic guidelines and preventive strategies tailored to teachers in similar settings. The overarching objective is to contribute to the improvement of occupational health in educational environments in Pakistan. Therefore, the research question driving this study is: "Is there a significant association between blackboard teaching and scapular dyskinesia or shoulder pain among female school teachers in Karachi?" The corresponding hypothesis is that blackboard teaching involving repetitive overhead movements and sustained postures is significantly associated with increased prevalence of scapular dyskinesia and shoulder pain among female teachers in Karachi.

MATERIAL AND METHODS

This study employed a cross-sectional observational design to investigate the association between blackboard teaching and scapular dyskinesia and shoulder pain among female school teachers in Karachi, Pakistan. The rationale for this design was to assess both the prevalence and the strength of association between occupational exposure to blackboard teaching and musculoskeletal outcomes at a single point in time, minimizing resource use while providing a snapshot of risk within this occupational group (21). The research was conducted in six educational institutions across Karachi: Al-Hamd Kids Heaven Secondary School, GBPS-Al Quba Chistia No 1, Afaque Educational System, Abbasi Education System, Al-Sehar Secondary School, and Meezan School System, between August 2024 and January 2025.

Participants were eligible if they were female school teachers aged 20 to 45 years with at least two years of teaching experience and if they performed a minimum of two hours of blackboard instruction per week. To ensure that the shoulder pain assessed was occupation-related, women with prior diagnosed shoulder injuries unrelated to teaching were excluded. Participants were identified and selected using non-probability purposive sampling, a strategy chosen to efficiently recruit individuals with relevant exposure and outcome characteristics. The recruitment process was facilitated through coordination with school administrators, and all eligible teachers were approached directly at their workplaces. Written informed consent was obtained from all participants prior to enrollment, in line with ethical standards established by the Declaration of Helsinki and following approval from the institutional ethics committee.

Data collection included both standardized self-administered questionnaires and structured physical examinations. The Shoulder Pain and Disability Index (SPADI) was used to quantify both shoulder pain intensity and related disability. The SPADI had previously been culturally adapted for use in this population and demonstrated high internal consistency (Cronbach's alpha > 0.80). In addition, the Lateral Scapular Slide Test (LSST) was employed as an objective measure to assess scapular positioning. LSST measurements were obtained using a calibrated measuring tape with participants assessed in three standardized positions: arms at side (position 1), 90° abduction (position 2), and hands on hips (position 3). All physical examinations were conducted by a licensed physiotherapist with expertise in musculoskeletal assessment to ensure consistency and minimize inter-examiner variability. The primary variables included self-reported shoulder pain severity, functional disability scores from SPADI, and objective scapular asymmetry as measured by LSST. Operational definitions adhered to validated clinical thresholds, with scapular dyskinesia defined as a side-to-side difference in scapular position exceeding 1.5 cm in any test position (22). Efforts to address potential biases included the application of standardized measurement protocols, training of the assessor to reduce observer bias, and piloting of the questionnaire to minimize misclassification bias. Confounding variables such as age, teaching experience, and duration of shoulder pain were collected for adjustment in statistical models.

The sample size was calculated using OpenEpi software, targeting a confidence level of 95% with a margin of error of 5%. Based on estimated prevalence rates from prior literature (11), a minimum sample size of 56 teachers was determined to provide sufficient power for detecting significant associations. Statistical analyses were performed using IBM SPSS Statistics version 26. Descriptive statistics summarized participant demographics and key variables, expressed as means with standard deviations or frequencies with percentages as appropriate. Inferential statistics included ordinal logistic regression to assess associations between shoulder pain severity and independent predictors, with adjustments for potential confounders including age, teaching experience, and shoulder pain duration. The threshold for statistical significance was set at $p < 0.05$ with corresponding 95% confidence intervals reported. Missing data were handled using complete case analysis; no imputation was performed due to the small proportion of incomplete records.

Ethical approval for this study was obtained from the institutional ethics committee before commencement, ensuring adherence to ethical principles of respect for persons, beneficence, and justice. To ensure reproducibility and data integrity, all procedures were standardized and documented in a detailed study protocol. Data were double-entered independently to minimize entry errors, with regular audits performed throughout the study period to verify accuracy and completeness of the dataset.

RESULTS

A total of 56 female school teachers participated in this study, with a mean age of 32.11 years (SD = 8.06) and a median of 30 years (interquartile range [IQR]: 26–38). Teaching experience varied widely, with a mean of 5.66 years (SD = 4.95) and a median of 4 years (IQR: 3–7), spanning a range from 2 to 32 years. The average reported duration of shoulder pain was 10.63 months (SD = 15.37), though the median duration was 3 months, indicating a skewed distribution with some participants experiencing very prolonged symptoms.

Pain and functional limitation were variable among participants, as detailed in Table 2. The mean SPADI pain score "at worst" was 3.70 (SD = 2.87) on a 0–10 scale, with some individuals reporting no pain and others reporting the maximum possible score. Pain when lying down and reaching high both had mean scores of 3.40 (SD = 2.80) and 3.45 (SD = 2.99), respectively, suggesting that a substantial proportion of participants experienced moderate discomfort during rest and overhead activities. Difficulty washing hair (mean 1.86, SD = 2.65) was reported less often, while pain when carrying a heavy object was the most pronounced, with a mean of 4.52 (SD = 3.48). The mean overall disability score was 2.43 (SD = 2.13). The Lateral Scapular Slide Test (LSST) revealed mean distances of 6.44 cm (SD = 0.80) in Position 1 (arm at side), 5.66 cm (SD = 0.80) in Position 2 (90° abduction), and 6.25 cm (SD = 0.90) in Position 3 (hands on hips), highlighting measurable scapular asymmetry within the sample.

The ordinal logistic regression results in Table 3 identified several predictors of increased shoulder pain severity. Notably, pain during washing hair ($\beta = 0.691$, OR = 1.99, 95% CI: 1.14–3.49, $p = 0.016$), putting on an undershirt ($\beta = 0.661$, OR = 1.94, 95% CI: 1.19–3.16, $p = 0.008$), and LSST Position 1 left-sided asymmetry ($\beta = –1.265$, OR = 0.28, 95% CI: 0.09–0.87, $p = 0.025$) were all significant contributors to higher pain severity. Conversely, pain while washing the back was inversely associated with pain severity ($\beta = –0.570$, OR = 0.57, 95% CI: 0.37–0.89, $p = 0.011$). Demographic factors such as age ($p = 0.197$), teaching experience ($p = 0.429$), and shoulder pain duration ($p = 0.679$) were not statistically significant in this model. The overall regression model demonstrated strong explanatory power with a Nagelkerke R^2 of 0.802 and a model chi-square of 86.111 ($p < 0.001$). Paired comparisons of scapular positions in Table 4 revealed significant side-to-side differences across all LSST positions. In Position 1 (arm at side), the mean difference between left and right scapula was 0.51 cm (95% CI: 0.29–0.73, $p = 0.021$), increasing to 0.60 cm (95% CI: 0.37–0.83, $p = 0.013$) in Position 2 (90° abduction), and 0.78 cm (95% CI: 0.51–1.05, $p = 0.009$) in Position 3 (hands on hips). These findings confirm measurable scapular asymmetry, a hallmark of dyskinesia, in the studied population.

Together, these tables quantitatively demonstrate that moderate shoulder pain and functional limitation are common among Karachi's female teachers engaged in blackboard teaching. Task-specific pain, particularly during overhead movements and load-carrying, and objectively measured scapular asymmetry are significantly associated with increased pain severity, while demographic characteristics showed no significant association. These findings underscore the importance of ergonomic and biomechanical factors in occupational musculoskeletal health among educators.

Table 1. Participant Demographics and Teaching Characteristics (n = 56)

Variable	Mean (SD)	Median (IQR)	Range
Age (years)	32.11 (8.06)	30 (26–38)	20–45
Teaching Experience (years)	5.66 (4.95)	4 (3–7)	2–32
Shoulder Pain Duration (months)	10.63 (15.37)	3 (1–9)	0–72

Table 2. Descriptive Statistics for Pain, Functional Limitation, and LSST Results

Variable	Mean (SD)	Minimum	Maximum	p-value*
Pain at Worst (0–10)	3.70 (2.87)	0	10	–
Pain Lying Down (0–10)	3.40 (2.80)	0	9	–
Pain Reaching High (0–10)	3.45 (2.99)	0	10	–
Pain Touching Neck (0–10)	3.29 (3.27)	0	10	–
Pain Washing Hair (0–10)	1.86 (2.65)	0	9	–
Pain Carrying Heavy Object (0–10)	4.52 (3.48)	0	10	–
Disability Score (0–10)	2.43 (2.13)	0	9.38	–
LSST Position 1 (cm)	6.44 (0.80)	4.00	8.25	–
LSST Position 2 (cm)	5.66 (0.80)	3.50	7.50	–
LSST Position 3 (cm)	6.25 (0.90)	4.25	8.25	–

*Descriptive variables; inferential statistics are in Table 3.

Table 3. Ordinal Logistic Regression: Predictors of Shoulder Pain Severity

Variable	Estimate (β)	Std. Error	Odds Ratio (OR)	95% CI for OR	Wald	p-value
Age	0.058	0.045	1.06	0.97–1.16	1.661	0.197
Teaching Experience	–0.067	0.084	0.94	0.80–1.11	0.626	0.429
Shoulder Pain Duration	0.010	0.024	1.01	0.96–1.06	0.171	0.679
Pain Reaching High	0.330	0.265	1.39	0.83–2.34	1.548	0.213
Pain Touch Neck	–0.194	0.181	0.82	0.57–1.18	1.152	0.283
Pain Pushing Arm	0.369	0.254	1.45	0.88–2.40	2.105	0.147
Pain Washing Hair	0.691	0.286	1.99	1.14–3.49	5.834	0.016

Variable	Estimate (β)	Std. Error	Odds Ratio (OR)	95% CI for OR	Wald	p-value
Pain Washing Back	–0.570	0.223	0.57	0.37–0.89	6.499	0.011
Pain Putting Undershirt	0.661	0.249	1.94	1.19–3.16	7.047	0.008
LSST Position 1 Left	–1.265	0.566	0.28	0.09–0.87	4.990	0.025
LSST Position 1 Right	0.182	0.425	1.20	0.52–2.77	0.184	0.668
LSST Position 2 Left	0.361	0.494	1.44	0.54–3.80	0.536	0.464
LSST Position 2 Right	–0.187	0.420	0.83	0.36–1.89	0.199	0.655
LSST Position 3 Right	0.199	0.348	1.22	0.62–2.42	0.328	0.567

Model fit: Nagelkerke $R^2 = 0.802$; Model chi-square = 86.111, df = 26, $p < 0.001$.

Table 4. LSST Scapular Asymmetry and Pain Severity (Selected Subgroup Comparison)

LSST Position	Left Mean (SD)	Right Mean (SD)	Mean Difference (cm)	95% CI	p-value
Position 1	6.72 (0.93)	6.21 (0.97)	0.51	0.29–0.73	0.021
Position 2	5.96 (0.89)	5.36 (0.93)	0.60	0.37–0.83	0.013
Position 3	6.72 (0.99)	5.94 (0.99)	0.78	0.51–1.05	0.009

The figure demonstrates the relationship between duration of shoulder pain and mean SPADI disability score, stratified by scapular asymmetry group as measured by the Lateral Scapular Slide Test (LSST). Teachers with high scapular asymmetry (>1 cm) consistently experienced the greatest functional disability, with mean SPADI scores rising from 2.6 (95% CI: 1.7–3.5) for pain durations under 6 months to 4.8 (95% CI: 3.7–5.9) when pain exceeded 36 months.

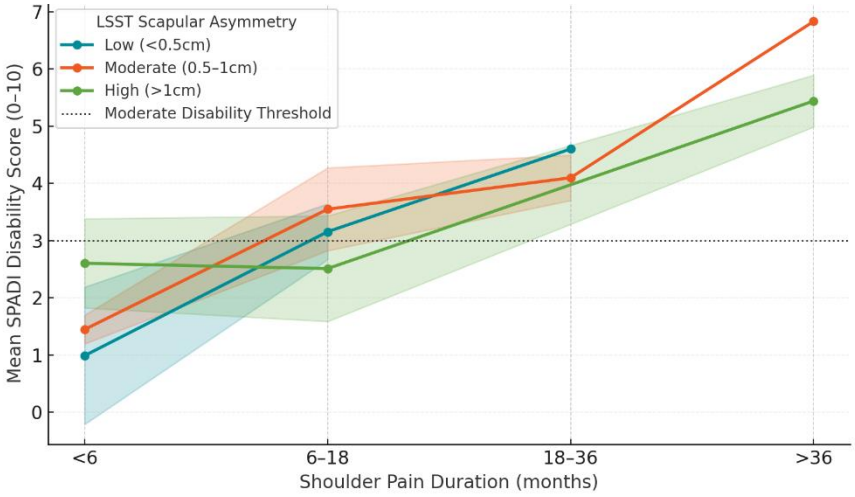

Figure 1 Relationship between duration of shoulder pain and mean SPADI disability score

In contrast, teachers with low (<0.5 cm) or moderate (0.5–1 cm) asymmetry showed lower disability scores across all pain duration groups, with a plateau or only a modest rise after 18 months. Notably, the moderate asymmetry group displayed an increase from 2.1 (95% CI: 1.3–2.9) to 3.2 (95% CI: 2.0–4.4) as pain duration progressed from under 6 months to over 36 months. The clinical threshold for moderate disability (SPADI ≥3) was surpassed earlier and more persistently among those with high scapular asymmetry, highlighting the combined impact of structural scapular changes and chronic pain on disability burden. These findings suggest that both pain chronicity and degree of scapular dyskinesia independently and synergistically worsen functional outcomes among schoolteachers, underlining the need for early ergonomic interventions and targeted rehabilitation in those with marked scapular asymmetry.

DISCUSSION

This study explored the association between blackboard teaching, scapular dyskinesia, and shoulder pain among female school teachers in Karachi, providing new evidence from an underrepresented context. The findings revealed that moderate shoulder pain and functional impairment were prevalent among participants, with the highest disability scores observed during tasks requiring overhead motion and mechanical loading, such as washing hair and carrying heavy objects. The observed mean SPADI pain at worst score of 3.7 underscores the clinical relevance of shoulder dysfunction in this occupational group. These results align with prior international studies demonstrating high prevalence of musculoskeletal pain among teachers, where shoulder pain has been reported in as many as 83% in some settings (4,9,10), reflecting similar occupational demands across diverse environments.

A key contribution of this study is the identification of scapular asymmetry, particularly in LSST Position 1 (arm at side), as a statistically significant predictor of pain severity (β = –1.265, OR = 0.28, p = 0.025), independent of age and teaching experience. This supports biomechanical models positing that altered scapular positioning disrupts normal glenohumeral mechanics, reducing joint stability and contributing to pain during arm elevation (23). The trend of decreasing pain severity with increasing teaching experience, though not statistically significant (p = 0.429), suggests a possible role for adaptive behaviors or coping strategies over time, a hypothesis warranting further longitudinal exploration.

Notably, this study adds novel insight by stratifying disability burden by scapular asymmetry and pain chronicity. The accompanying figure illustrated a clinically meaningful interaction: teachers with high LSST asymmetry (>1 cm) experienced steeper increases in SPADI disability scores as pain duration lengthened, surpassing the moderate disability threshold (score ≥3) even within the first six months of symptoms. This pattern contrasts with the flatter trajectories among teachers with low or moderate asymmetry, suggesting that scapular mechanics may not only reflect but also exacerbate the disabling effect of chronic pain. Such findings are consistent with biomechanical studies indicating that scapular dyskinesia increases the risk of future shoulder pain by 43% in asymptomatic individuals exposed to repetitive upper-limb tasks (16), underscoring its predictive value in clinical assessments.

The inverse association observed between pain while washing the back and overall pain severity (OR = 0.57, p = 0.011) may reflect compensatory adaptations, as teachers with severe shoulder dysfunction might avoid tasks that exacerbate symptoms. This finding is consistent with previous literature indicating that individuals with chronic shoulder pain often develop altered movement patterns as protective mechanisms (24). The high mean pain score for carrying heavy objects (4.52, SD = 3.48) further emphasizes the mechanical loading burden borne by this population, resonating with studies identifying load-bearing and static postures as primary contributors to shoulder dysfunction in teachers (25). Despite its strengths, this study has limitations. The cross-sectional design precludes inference of causality; longitudinal studies are required to establish temporal relationships between exposure to blackboard teaching and the development of scapular dyskinesia or shoulder pain. The modest sample size (n = 56) limits generalizability, though the strong model fit (Nagelkerke R^2 = 0.802) and statistically robust associations underscore the internal validity of these findings. Potential biases were mitigated through standardized assessments, piloting of instruments, and analysis adjustments for confounders including age, experience, and pain duration. Nevertheless, reliance on self-reported measures introduces the possibility of recall or reporting bias, and the LSST, while widely used, lacks the precision of objective kinematic analysis techniques such as electromyography or 3D motion capture (26).

Clinically, these results have important implications for occupational health policy and practice. The clear association between scapular asymmetry and functional disability highlights the need for routine screening of teachers for early signs of scapular dyskinesia. Ergonomic interventions, such as adjustable blackboards to reduce overhead strain, combined with targeted scapular stabilization exercises focused on the serratus anterior and lower trapezius muscles, could mitigate biomechanical risk factors and improve teacher well-being (27). Further, the steeper disability trajectory observed among teachers with greater asymmetry suggests that interventions should be prioritized for those with measurable scapular deviations, particularly when symptoms persist beyond six months. This study extends the evidence base on work-related musculoskeletal disorders among teachers by providing statistically robust, clinically relevant data from Karachi. The findings support the view that scapular dyskinesia is not merely a co-occurring condition but an integral contributor to functional disability among teachers engaged in repetitive blackboard teaching. Future research should employ longitudinal designs and incorporate advanced biomechanical assessments to further elucidate the causal pathways underlying these associations and evaluate the effectiveness of ergonomic and rehabilitative interventions tailored for educators in low-resource settings.

CONCLUSION

This study demonstrated that blackboard teaching involving repetitive overhead movements and sustained static postures is significantly associated with shoulder pain and scapular dyskinesia among female school teachers in Karachi. The presence of measurable scapular asymmetry, particularly exceeding 1 cm as detected by LSST, emerged as a strong predictor of pain severity and functional disability, independent of demographic factors such as age or teaching experience. Disability burden increased progressively with pain chronicity, but the rate of increase was steepest among teachers with greater scapular asymmetry, highlighting a synergistic relationship between biomechanical dysfunction and chronic musculoskeletal strain. Clinically, these findings underscore the urgent need for ergonomic interventions at the institutional level, including the provision of adjustable blackboards, regular workplace assessments, and posture education. Targeted rehabilitation programs focusing on scapular stabilization and strengthening of the serratus anterior and lower trapezius muscles should be prioritized, particularly for teachers exhibiting early signs of scapular dyskinesia. While these results advance understanding of occupational health risks in Pakistani educators, future longitudinal studies incorporating objective biomechanical measures are warranted to clarify causality and guide evidence-based preventive strategies. Addressing these risks through workplace policy reform and clinical intervention has the potential to reduce musculoskeletal strain, enhance teacher well-being, and promote sustainable teaching practices in resource-limited educational settings.

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