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Original Article

Prevalence of Brachioradialis Trigger Points and Their Association with Grip Strength and Functional Activities Among Factory Workers in Sialkot: A Cross-Sectional Study

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ABSTRACT

Background: Repetitive manual activities may contribute to upper-extremity musculoskeletal symptoms among industrial workers. However, evidence regarding the prevalence and functional associations of brachioradialis myofascial trigger points (TrPs) in occupational populations remains limited. **Objective:** To determine the prevalence of brachioradialis TrPs among factory workers in Sialkot, Pakistan, and examine their associations with handgrip strength, elbow pain, and functional activities. **Methods:** This analytical cross-sectional study included 374 male workers aged 20–40 years recruited through convenience sampling from sports goods and surgical instrument factories in Sialkot. Bilateral brachioradialis TrPs were assessed by clinical palpation, handgrip strength was measured using an electronic dynamometer, and elbow-related pain and function were evaluated using the Oxford Elbow Score (OES). Data were analyzed using chi-square tests, Mann–Whitney U tests, and Spearman's rank correlations. **Results:** Brachioradialis TrPs were identified in 168 workers (44.9%; 95% CI: 39.9–50.0%), including 64 (17.1%) with bilateral involvement. Reduced grip strength was observed in 82.1% of workers with TrPs compared with 26.7% without TrPs ($\chi^2 = 113.90$; $p < 0.001$). The mean total OES was 77.31 ± 15.47 among workers with TrPs and 98.22 ± 6.07 among those without, with lower scores across all three OES domains. The number of TrPs was positively correlated with reduced grip-strength classification ($\rho = 0.600$) and negatively correlated with total OES ($\rho = -0.792$). **Conclusion:** Brachioradialis TrPs were common among the sampled male factory workers and were associated with reduced grip strength, greater elbow-related pain, and poorer functional status. Longitudinal studies are needed to clarify temporal relationships and evaluate the clinical significance of these findings. **Keywords:** Brachioradialis; Myofascial Trigger Points; Handgrip Strength; Oxford Elbow Score; Occupational Health; Work-Related Musculoskeletal Disorders.

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) constitute a major occupational health concern, particularly among workers engaged in repetitive manual activities, sustained gripping, forceful exertions, and prolonged or awkward upper-limb postures. These disorders can contribute to pain, functional limitation, reduced work capacity, and productivity losses across manufacturing industries (1–4). Epidemiological and biomechanical investigations

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have identified repetitive movements, high hand forces, non-neutral joint positions, and inadequate recovery periods as important occupational exposures associated with upper-extremity musculoskeletal disorders (5,6). A systematic review and meta-analysis undertaken for the World Health Organization/International Labour Organization Joint Estimates further highlighted the widespread occupational exposure to ergonomic risk factors (7). Although upper-limb musculoskeletal complaints have been extensively investigated, the contribution of individual forearm muscles and localized myofascial abnormalities to occupational pain and functional impairment remains comparatively less understood.

Sialkot, Pakistan, is an important manufacturing centre for sports goods and surgical instruments, where production activities frequently involve cutting, sewing, grinding, polishing, metal shaping, and repetitive handling of tools and materials. Such activities may expose workers to sustained forearm muscle activation, repetitive gripping, static loading, and cumulative mechanical demands. Previous investigations among manufacturing and assembly-line workers have identified associations between repetitive occupational exposure and upper-extremity musculoskeletal symptoms (2–6). Lotter et al. specifically investigated surgical device mechanics and reported associations between repetitive industrial tasks, including grinding, polishing, and packaging, and upper-extremity musculoskeletal complaints (8). Nevertheless, these investigations have primarily assessed regional symptoms or occupational ergonomic exposures rather than the involvement of specific forearm muscles. This distinction is important because localized myofascial dysfunction may coexist with broader work-related musculoskeletal complaints.

Myofascial trigger points (TrPs) are commonly described as hyperirritable sites within palpable taut bands of skeletal muscle that may produce localized tenderness, referred pain, restricted movement, and altered muscle performance (9,10). Their proposed pathophysiology involves disturbances in motor endplate activity, sustained localized contraction, impaired microcirculation, metabolic changes, and peripheral nociceptor sensitization (9,10). Experimental evidence has additionally suggested a possible contribution of altered muscle spindle activity to trigger-point development, although the precise mechanisms remain incompletely established (11). TrPs are generally classified as active when they reproduce clinically familiar or spontaneous pain and latent when tenderness is elicited primarily by mechanical stimulation (12). However, clinical identification remains challenging because diagnostic criteria and palpation-based assessment procedures vary across studies. Li et al., in a systematic review of physical therapy trials, identified heterogeneity in the diagnostic criteria used to establish the presence of myofascial trigger points (13). Mayoral-del Moral et al. further examined the validity and interexaminer reliability of clinical assessment in upper-quarter muscles, emphasizing the methodological importance of reproducible examination procedures (14).

The brachioradialis is a superficial forearm muscle originating from the lateral supracondylar region of the humerus and inserting near the radial styloid process. It contributes primarily to elbow flexion, particularly when the forearm is maintained in a neutral position, and participates in stabilization and coordinated upper-limb activities involving grasping and object manipulation. Electromyographic investigations have demonstrated its recruitment during common grasping tasks (15), while biomechanical research involving repetitive manual packaging has identified fatigue-related changes in brachioradialis activity (16). Repetitive loading or sustained contraction of this muscle may therefore have implications for forearm discomfort and performance during industrial activities. Kim described brachioradialis-related pain as a potentially underrecognized source of lateral forearm symptoms that can resemble lateral epicondylitis and other upper-extremity disorders (17). Such diagnostic overlap is relevant to manufacturing workers because repeated manual loading can produce symptoms involving multiple muscular and tendinous structures.

Clinical observations also suggest that brachioradialis trigger points may contribute to elbow-related pain presentations. Aggarwal et al. examined myofascial trigger points in five upper-limb muscles among 40 individuals with lateral epicondylitis and identified the brachioradialis as the most frequently affected muscle (18). Although these findings demonstrate the potential clinical relevance of brachioradialis TrPs, they were obtained from a symptomatic clinical population and cannot be directly generalized to occupational groups without diagnosed elbow pathology. Furthermore, studies of lateral elbow pain often focus on the wrist extensor musculature, tendon abnormalities, and regional symptoms rather than systematically evaluating brachioradialis trigger-point prevalence in otherwise working populations. Consequently, the frequency and functional implications of these localized muscular findings in industrial workers remain uncertain.

Handgrip strength is a widely used indicator of upper-limb muscular performance and functional capacity. Its measurement provides a practical assessment of force generation during activities requiring grasping, carrying, tool handling, and sustained manual effort (19). Research among industrial workers has demonstrated that neck and wrist pain may adversely affect grip performance (20), while investigations of forearm muscle stiffness have suggested relationships between mechanical muscle properties and grip strength (21). Jain et al. additionally examined associations between grip strength, upper-limb muscle activity, and occupational experience among manual workers, demonstrating the importance of work-related and individual characteristics when interpreting grip performance (22). These findings suggest that muscular pain, altered loading patterns, and occupational demands may be associated with grip-strength differences. However, evidence specifically examining the association between brachioradialis TrPs and reduced grip strength in factory workers remains limited. Moreover, the relationship between localized trigger-point findings and patient-reported elbow pain, functional activity, and psychosocial consequences has not been adequately characterized in this occupational population.

Despite increasing recognition of work-related upper-extremity disorders, important evidence gaps persist regarding the prevalence, anatomical distribution, and functional correlates of brachioradialis trigger points among manufacturing workers. Existing research has predominantly investigated general musculoskeletal symptoms, occupational ergonomic exposures, or trigger points in patients with established musculoskeletal conditions, leaving limited evidence from actively employed industrial populations. In particular, data from sports goods and surgical instrument factory workers in Sialkot are scarce. Addressing this gap may improve understanding of the clinical relevance of brachioradialis TrPs in occupational health assessment without assuming that their presence necessarily causes impaired performance. Therefore, the present study aimed to estimate the prevalence of brachioradialis trigger points among factory workers in Sialkot, Pakistan, and to examine their association with grip strength, elbow pain, and functional activities.

MATERIALS AND METHODS

Study Design and Setting

An observational analytical cross-sectional study was conducted among workers employed in sports goods and surgical instrument manufacturing factories in Sialkot, Punjab, Pakistan. The study investigated the prevalence of brachioradialis myofascial trigger points (TrPs) and their associations with handgrip strength, elbow pain, and functional activities. The participating factories involved occupational tasks requiring repetitive upper-limb movements, manual handling, gripping, cutting, sewing, grinding, polishing, and metal shaping. The research process commenced with title approval on 20 November 2025, followed by synopsis defense on 29 April 2026, and concluded with report submission on 28 September 2026. Data collection was reported to have been completed within six months of university research committee approval. The study was structured and reported with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for cross-sectional research.

Study Population and Eligibility Criteria

The target population comprised factory workers aged 20–40 years who were involved in repetitive upper-limb activities in sports goods and surgical instrument manufacturing industries in Sialkot. Both male and female workers were considered eligible, irrespective of their duration of employment or daily working hours. Workers were excluded if they had a recent upper-limb fracture or surgical intervention, a previously diagnosed peripheral neuropathy, cervical radiculopathy, or lateral epicondylitis. Individuals with skin lesions, open wounds, or other local conditions over the forearm that prevented safe palpation were also excluded. Workers who reported using analgesic medication during the preceding 24 hours were ineligible because recent analgesic exposure could potentially influence pain-related clinical assessment. Participants were recruited using non-probability convenience sampling according to their availability during factory visits and their willingness to participate. Although eligibility was not restricted by sex, the final sample consisted entirely of male workers because no female workers were present in the shop-floor workforce of the factories visited.

Sample Size Determination

The required sample size was estimated using OpenEpi on the basis of a finite target population of approximately 20,000 factory workers, an anticipated prevalence of 45%, a 95% confidence level, and a 5% absolute margin of

error. The initial sample size for estimating a population proportion was determined using $n_0 = Z^2p(1–p)/d^2$, where Z represents the standard normal value corresponding to a 95% confidence level (1.96), p the anticipated prevalence (0.45), and d the acceptable margin of error (0.05). Applying the finite population correction, $n = n_0/[1+(n_0–1)/N]$, where N = 20,000, yielded a minimum sample size of approximately 374 participants after rounding upward. Accordingly, 374 factory workers were included in the final study sample.

Study Variables and Outcome Measures

The principal exposure variable was the presence or absence of clinically identified brachioradialis TrPs. The prevalence and anatomical distribution of TrPs were evaluated separately for the right and left forearms. The principal functional outcomes were handgrip strength and self-reported elbow-related pain and functional performance. Additional variables included age, body weight, occupational activity, daily working hours, and duration of employment.

Demographic and Occupational Assessment

A structured paper-based demographic and occupational information form was used to collect participant characteristics. Recorded variables included age, body weight, occupation, daily working hours, years of occupational experience, and principal industrial activity. Daily working hours were categorized as less than 4 hours, 4–6 hours, 7–8 hours, and more than 8 hours. Occupational experience was classified as less than 1 year, 1–5 years, 6–10 years, and more than 10 years. The principal occupational activities were categorized as cutting, sewing, polishing, grinding, and metal shaping. These variables were collected to characterize the study population and describe the occupational context in which repetitive forearm muscle loading occurred.

Assessment of Brachioradialis Myofascial Trigger Points

Both brachioradialis muscles were examined clinically using manual pincer palpation. The examination was directed toward identifying palpable taut muscle bands, localized tender nodules, and pain responses consistent with myofascial trigger-point characteristics. Clinical recognition of TrPs was based on established palpatory features described in the literature, although variation in diagnostic criteria and examiner agreement has been recognized (13,14). A TrP was recorded when a palpable taut band containing a tender nodule was identified and mechanical pressure reproduced pain recognized by the participant as familiar. A local twitch response, when observed, was considered an additional supportive finding rather than a mandatory diagnostic criterion.

The examination was performed bilaterally, and the number of identified TrPs in each forearm was recorded. Participants were subsequently classified according to whether TrPs were absent or present in at least one brachioradialis muscle. Anatomical involvement was categorized as right forearm only, left forearm only, or bilateral. Two trained examiners conducted the palpation assessments and were blinded to participants' handgrip-strength results. This separation was intended to limit the influence of grip-performance findings on clinical identification of TrPs.

Handgrip Strength Measurement

Isometric handgrip strength was assessed using an electronic hand dynamometer (CAMRY, model EH101). Handgrip dynamometry provides a practical quantitative measure of voluntary gripping force and is widely employed in assessments of upper-limb functional performance (19). Participants were seated upright in a chair, with the shoulder adducted and neutrally rotated, the elbow flexed to approximately 90°, and the forearm maintained in a neutral position. The wrist was positioned between 0° and 30° of extension and between 0° and 15° of ulnar deviation. Each participant was instructed to grip the dynamometer as firmly as possible while maintaining the standardized testing posture. Two to three maximal voluntary gripping trials were performed, and the highest recorded value was retained for assessment. For the reported categorical analysis, handgrip strength was classified as either normal or reduced. Grip-strength category was subsequently compared between participants with and without brachioradialis TrPs.

Assessment of Elbow Pain and Functional Activities

Elbow-related pain and functional performance were evaluated using the Oxford Elbow Score (OES), a patient-reported outcome instrument comprising 12 items distributed across three domains: elbow function, elbow pain, and social–psychological effects. Each domain contains four items evaluating elbow-related symptoms and their

impact on daily activities during the preceding four weeks (23). Individual items are evaluated using five response categories. Scores were transformed to a 0–100 scale, with higher scores indicating better elbow-related health, less pain, and fewer functional limitations. The three OES domains were examined separately, and an overall OES value was used to evaluate elbow-related functional status. Domain-specific and total scores were compared between participants with and without brachioradialis TrPs. Internal consistency of the OES in the study sample was assessed using Cronbach's alpha, which was reported as 0.976.

Data Collection Procedure

Eligible factory workers were approached during workplace visits and provided with an explanation of the study objectives, assessment procedures, anticipated benefits, possible discomforts, confidentiality arrangements, and voluntary nature of participation. Written informed consent was obtained before collecting study information or conducting physical assessments. Participants first completed the structured demographic and occupational information form and the Oxford Elbow Score questionnaire. The clinical examination of both brachioradialis muscles and handgrip-strength testing were subsequently performed using the assessment procedures described above. The collected information was used to determine the overall prevalence and side distribution of brachioradialis TrPs, categorize handgrip strength, and evaluate differences in elbow-related pain and functional performance according to TrP status.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics, version 26.0. Descriptive statistics were calculated for demographic characteristics, occupational variables, trigger-point findings, handgrip-strength classification, and Oxford Elbow Scores. Categorical variables were summarized using frequencies and percentages. Continuous variables were described using means and standard deviations. The overall prevalence of brachioradialis TrPs was calculated as the proportion of participants with at least one identified TrP and expressed with a 95% confidence interval. The distribution of continuous variables was assessed using the Shapiro–Wilk test. The reported normality assessment indicated statistically significant departures from normality for the continuous variables examined ($p < 0.001$). Consequently, non-parametric statistical procedures were applied to the relevant between-group comparisons and correlation analyses.

The association between brachioradialis TrP status (present versus absent) and handgrip-strength category (normal versus reduced) was examined using Pearson's chi-square test of independence. Differences in OES total and domain scores between workers with and without brachioradialis TrPs were assessed using the Mann–Whitney U test. Spearman's rank correlation coefficient (ρ) was used to investigate associations between the number of identified brachioradialis TrPs and grip-strength category, as well as between the number of TrPs and overall OES. All statistical tests were interpreted using a significance threshold of $p < 0.05$. The reported association analyses were unadjusted, and no multivariable confounder-adjusted analysis was performed.

Ethical Considerations

The study documentation identifies the University of Sialkot Ethics/Research Committee as the approving authority, with title approval recorded on 20 November 2025 and synopsis defense on 29 April 2026. Participation was voluntary, and written informed consent was obtained before data collection. Participants were informed of the study objectives, assessment procedures, potential benefits and risks, and their right to withdraw without adverse consequences. Confidentiality of participant information was maintained throughout data collection and analysis. The study involved non-invasive clinical palpation, handgrip-strength measurement, and administration of a self-reported functional assessment questionnaire.

RESULTS

Participant Characteristics

A total of 374 factory workers were included in the study. All participants were male, reflecting the absence of female shop-floor workers at the factories visited, despite eligibility extending to both sexes. Participants were aged 20–40 years, with a mean age of 30.25 ± 6.39 years. The age distribution was relatively balanced, with 104 (27.8%) workers aged 20–25 years, 95 (25.4%) aged 26–30 years, 73 (19.5%) aged 31–35 years, and 102 (27.3%) aged 36–40 years.

Most participants, 289 (77.3%), reported working 7–8 hours daily, while 54 (14.4%) worked more than 8 hours. Regarding occupational experience, 158 (42.2%) had worked for 1–5 years, followed by 116 (31.0%) with 6–10 years of experience. Sewing was the most frequently reported occupational activity (29.7%), followed by cutting (27.5%), grinding (20.9%), polishing (11.5%), and metal shaping (10.4%). The demographic and occupational characteristics of the participants are presented in Table 1.

Table 1. Demographic and occupational characteristics of factory workers (N = 374)

Characteristics	Frequency (n)	Percentage (%)
Sex		
Male	374	100.0
Age group (years)		
20–25	104	27.8
26–30	95	25.4
31–35	73	19.5
36–40	102	27.3
Daily working hours		
Less than 4	4	1.1
4–6	27	7.2
7–8	289	77.3
More than 8	54	14.4
Occupational experience (years)		
Less than 1	47	12.6
1–5	158	42.2
6–10	116	31.0
More than 10	53	14.2
Primary occupational activity		
Sewing	111	29.7
Cutting	103	27.5
Grinding	78	20.9
Polishing	43	11.5
Metal shaping	39	10.4

Age: mean ± SD 30.25 ± 6.39 years (range 20–40). Percentages use N = 374.

Prevalence and Anatomical Distribution of Brachioradialis Trigger Points

Brachioradialis myofascial trigger points (TrPs) were identified in 168 of the 374 participants, corresponding to an overall prevalence of 44.9% (95% confidence interval [CI]: 39.9–50.0%). The remaining 206 workers (55.1%) had no clinically identified brachioradialis TrPs. Regarding anatomical distribution, right-sided involvement was identified in 131 workers (35.0% of the total sample), whereas left-sided involvement was observed in 101 workers (27.0%). Among the 168 workers with TrPs, 67 (39.9%) had exclusively right-sided involvement, 37 (22.0%) had exclusively left-sided involvement, and 64 (38.1%) had bilateral involvement. Thus, 104 affected workers (61.9%) had unilateral TrPs, whereas 64 (38.1%) had TrPs in both forearms. The prevalence and laterality distribution of brachioradialis TrPs are presented in Table 2.

Association Between Brachioradialis Trigger Points and Handgrip Strength

Reduced handgrip strength was documented in 193 participants (51.6%), whereas 181 (48.4%) were categorized as having normal grip strength. Among workers with brachioradialis TrPs, 138 of 168 (82.1%) demonstrated reduced grip strength, compared with 55 of 206 (26.7%) workers without TrPs. Conversely, normal grip strength was observed in only 30 workers (17.9%) with TrPs, compared with 151 (73.3%) without TrPs. Pearson's chi-square test demonstrated a statistically significant association between the presence of brachioradialis TrPs and grip-strength classification ($\chi^2 = 113.90$, df = 1, $p < 0.001$). The absolute difference in the proportion of workers with reduced grip strength between the two groups was 55.4 percentage points. Furthermore, the number of clinically identified TrPs showed a positive correlation with reduced grip-strength status (Spearman's $\rho = 0.600$, $p < 0.001$). These findings demonstrate a strong unadjusted association between brachioradialis TrP involvement and reduced handgrip performance. Table 3 presents the contingency analysis, while Figure 1 illustrates the distribution of normal and reduced grip-strength classifications according to TrP status.

Elbow Pain and Functional Activities

Oxford Elbow Score (OES) assessment demonstrated variability in elbow-related symptoms and functional performance across the study population. The overall mean OES was 88.83 ± 15.36 on the transformed 0–100 scale, with a reported median of 100 and a range of 35.42–100. Higher scores indicate better elbow-related health and fewer functional limitations.

Among the three OES domains, the social–psychological domain demonstrated the highest mean score (90.37 ± 15.35), followed by elbow function (88.44 ± 15.59) and elbow pain (87.67 ± 16.94). The distribution of total OES values was concentrated toward the upper end of the scale, suggesting that many workers reported relatively preserved elbow-related function, although a subgroup experienced appreciable pain and functional limitations.

At the individual-item level, difficulty carrying shopping bags was the most frequently reported limitation (40.9%), followed by difficulty lifting objects (40.6%). Usual elbow pain was reported by 39.0% of participants. Washing and dressing were less frequently affected, with 31.3% and 30.7% of workers, respectively, reporting some difficulty.

Table 2. Prevalence and anatomical distribution of brachioradialis trigger points (N = 374)

Trigger-point status	n	% of total sample	% of affected workers
Overall prevalence			
TrPs present	168	44.9	100.0
TrPs absent	206	55.1	—
Anatomical distribution			
Right forearm only	67	17.9	39.9
Left forearm only	37	9.9	22.0
Bilateral forearms	64	17.1	38.1
Any involvement by side			
Right forearm	131	35.0	78.0
Left forearm	101	27.0	60.1

Overall prevalence 44.9% (95% CI: 39.9–50.0%). Any involvement by side is overlapping.

Table 3. Association between brachioradialis trigger-point status and handgrip-strength classification (N = 374)

TrP status	Total n	Normal grip, n (%)	Reduced grip, n (%)
Absent	206	151 (73.3)	55 (26.7)
Present	168	30 (17.9)	138 (82.1)
Total	374	181 (48.4)	193 (51.6)

Pearson $\chi^2 = 113.90$; df = 1; $p < 0.001$. Row percentages are used except in the total row.

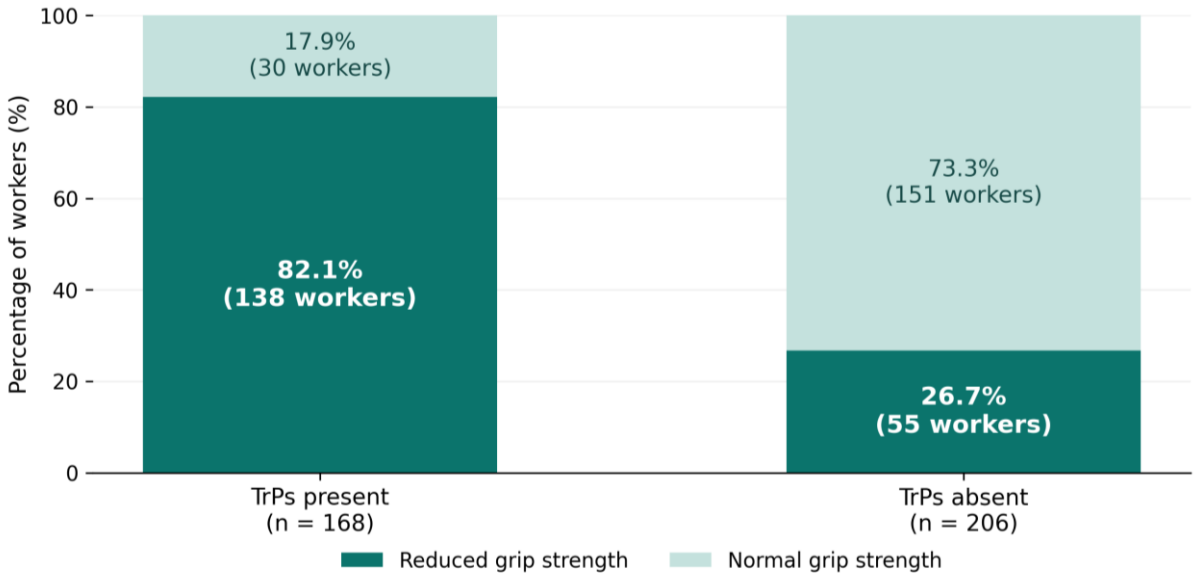


Figure 1. Distribution of handgrip-strength classifications by brachioradialis trigger-point status (N = 374). Reduced grip occurred in 82.1% of workers with TrPs and 26.7% without TrPs (Pearson $\chi^2 = 113.90$; df = 1; $p < 0.001$).

Comparison of Oxford Elbow Scores According to Trigger-Point Status

Workers with brachioradialis TrPs demonstrated consistently lower OES values across all three domains compared with workers without TrPs. The mean elbow-function score was 76.60 ± 15.49 among workers with TrPs, compared with 98.09 ± 6.20 among those without TrPs. Similarly, the social–psychological domain score was lower in workers with TrPs (80.10 ± 17.35) than in workers without TrPs (98.76 ± 5.14). The pain-domain score was 75.22 ± 16.74 in the TrP group, compared with 97.82 ± 7.99 in the non-TrP group.

The mean total OES was 77.31 ± 15.47 among participants with brachioradialis TrPs and 98.22 ± 6.07 among participants without TrPs, representing an unadjusted mean difference of 20.91 points. The original analysis

reported statistically significant Mann–Whitney comparisons for all OES domains and the total OES ($p < 0.001$ for each comparison). The number of identified brachioradialis TrPs also showed a strong negative correlation with the total OES (Spearman's $\rho = -0.792$, $p < 0.001$), indicating that greater recorded trigger-point involvement was associated with lower elbow-related functional scores. The detailed descriptive scores and originally reported significance levels are presented in Table 4.

Table 4. Comparison of Oxford Elbow Scores between workers with and without brachioradialis trigger points (N = 374)

OES component	TrPs absent (n = 206), mean ± SD	TrPs present (n = 168), mean ± SD	Mean difference (absent − present)	p value
Elbow function	98.09 ± 6.20	76.60 ± 15.49	21.49	< 0.001
Social–psychological	98.76 ± 5.14	80.10 ± 17.35	18.66	< 0.001
Pain	97.82 ± 7.99	75.22 ± 16.74	22.60	< 0.001
Total OES	98.22 ± 6.07	77.31 ± 15.47	20.91	< 0.001

OES = Oxford Elbow Score; SD = standard deviation. Higher scores are better. Means and reported p values are source-derived; mean differences are calculated from means. Original Mann–Whitney statistics require independent verification.

DISCUSSION

Principal Findings

The present study investigated the prevalence of brachioradialis myofascial trigger points (TrPs) and their associations with handgrip strength, elbow pain, and functional activities among 374 male workers employed in sports goods and surgical instrument manufacturing factories in Sialkot, Pakistan. Brachioradialis TrPs were identified in 44.9% of participants, with unilateral or bilateral involvement. Workers with TrPs demonstrated a substantially higher frequency of reduced grip strength than those without TrPs (82.1% versus 26.7%) and consistently lower Oxford Elbow Scores (OES) across the function, pain, and social–psychological domains. The mean total OES difference between the groups was 20.91 points. In addition, the number of identified TrPs was positively correlated with reduced grip-strength classification and negatively correlated with overall elbow-related functional status. Collectively, these findings indicate a substantial relationship between clinically identified brachioradialis TrPs and impaired upper-limb performance within the occupational population examined. However, the cross-sectional design does not establish whether TrPs preceded, contributed to, or developed alongside these functional limitations.

Prevalence of Brachioradialis Trigger Points in Occupational Populations

The observed prevalence of 44.9% suggests that localized brachioradialis trigger-point findings were common among the workers examined. Direct comparison with previous occupational studies is challenging because most epidemiological investigations have assessed regional musculoskeletal symptoms, diagnosed upper-extremity disorders, or ergonomic exposures rather than specifically evaluating brachioradialis TrPs. Nevertheless, the findings are consistent with the broader recognition that manufacturing workers experience substantial upper-extremity musculoskeletal morbidity. Ding et al. and Yang et al. documented work-related musculoskeletal problems in manufacturing populations in China, while Guerreiro et al. identified relationships between occupational characteristics and upper-limb symptoms among assembly-line workers (2–4). These studies provide an occupational context for the present findings but do not establish comparable muscle-specific prevalence estimates. More directly relevant clinical evidence was reported by Aggarwal et al., who examined 40 individuals with lateral epicondylitis and identified the brachioradialis as the most frequently involved muscle among five assessed upper-limb muscles (18). The agreement between the anatomical involvement described in that investigation and the present findings supports further consideration of the brachioradialis during assessments of lateral forearm symptoms. However, the populations differ substantially. Aggarwal et al. investigated patients with established lateral epicondylitis, whereas the present study examined actively employed factory workers and excluded individuals with diagnosed epicondylitis. Consequently, prevalence estimates from these populations cannot be considered directly interchangeable.

Myofascial trigger-point involvement has also been documented in other musculoskeletal pain populations. Monclús-Díez et al., in a systematic review of patients with radiating and non-radiating low back pain, demonstrated the relevance of TrPs in regional pain presentations (24). Although their anatomical focus differs from the forearm, the findings illustrate the wider clinical significance of myofascial abnormalities in musculoskeletal assessment.

The present study extends this investigative perspective to a specific forearm muscle within a working industrial population rather than a treatment-seeking clinical sample.

Occupational Exposure and Potential Mechanical Mechanisms

The occupational characteristics of the participants provide a plausible context for the high frequency of brachioradialis TrPs. Most workers performed 7–8 hours of work daily, while sewing, cutting, and grinding represented the predominant occupational activities. These tasks commonly involve repeated gripping, manual force application, sustained forearm positioning, and repetitive upper-limb movement. Previous research has associated occupational repetition, forceful exertion, awkward joint postures, and insufficient recovery periods with upper-extremity musculoskeletal disorders (5,6).

Lotter et al. examined surgical device mechanics and reported relationships between repetitive industrial activities, including grinding, polishing, and packaging, and upper-extremity musculoskeletal complaints (8). Similarly, Guo et al. investigated muscle fatigue during repetitive manual packaging and identified fatigue-related changes in brachioradialis activity (16). The latter investigation is particularly relevant because it provides muscle-specific biomechanical evidence linking repetitive occupational tasks with changes in brachioradialis activation. The present findings are compatible with the possibility that repeated occupational loading may be associated with localized muscular dysfunction.

Biological mechanisms proposed for TrP development include sustained contraction, altered motor endplate activity, disturbed local circulation, metabolic stress, and increased nociceptor sensitivity (9,10). Liu et al. additionally identified a potential role for muscle spindle activity in experimentally induced myofascial trigger-point phenomena (11). These proposed pathways offer possible explanations for the coexistence of localized tenderness, pain, and altered functional performance. However, the present study did not measure muscle activation, tissue perfusion, motor endplate activity, occupational force, movement frequency, or posture. Therefore, these mechanisms remain explanatory hypotheses derived from external evidence rather than processes demonstrated in the study population. The prevalence of TrPs was higher in the right forearm (35.0%) than the left (27.0%), while 17.1% of participants exhibited bilateral involvement. Differences in task execution, repetitive loading, or preferential upper-limb use may contribute to this distribution. Nevertheless, hand dominance was not recorded, and the association between occupational exposure and anatomical laterality was not directly analyzed. Accordingly, the observed asymmetry should not be interpreted as evidence that dominant-arm loading caused the trigger-point distribution.

Association Between Trigger Points and Handgrip Strength

One of the principal findings was the marked difference in handgrip-strength classification between workers with and without brachioradialis TrPs. Reduced grip strength was identified in 82.1% of affected workers compared with 26.7% of unaffected workers. The association was statistically significant, and the number of identified TrPs demonstrated a positive correlation with reduced grip-strength status. These observations indicate that brachioradialis TrP involvement was associated with impaired grip performance, although the analysis was unadjusted.

The findings are consistent with previous research linking upper-limb musculoskeletal symptoms and functional strength. Wollesen et al. demonstrated that neck and wrist pain were related to handgrip performance among industrial workers (20). Oshima and Shimao investigated relationships between forearm muscle stiffness and grip strength, indicating that mechanical properties of forearm musculature may be relevant to force production (21). Jain et al. further examined the relationship between upper-limb muscular activity, occupational experience, and grip strength among manual workers (22). These investigations collectively suggest that gripping performance reflects interactions among muscular function, pain, occupational exposure, and individual characteristics.

The brachioradialis contributes to elbow flexion and forearm stabilization during everyday grasping tasks, as demonstrated by investigations of forearm muscle activation during common grasp patterns (15). Localized pain or muscle tenderness may therefore influence the ability to sustain upper-limb positioning during maximal gripping. Pain-associated changes in motor recruitment and protective movement strategies may also contribute to reduced force production. Nevertheless, these explanations cannot establish that TrPs independently caused weaker grip strength in the present sample.

Importantly, reduced grip strength was also observed in 26.7% of workers without identified TrPs. This indicates that impaired grip performance was not confined to participants with brachioradialis involvement and may reflect other musculoskeletal conditions, occupational exposures, individual physiological characteristics, or variations in measurement. The absence of multivariable adjustment for age, occupational experience, task type, and other potential confounders further limits conclusions regarding the independent association of TrPs with grip strength.

Elbow Pain, Functional Activities, and Psychosocial Implications

The association between brachioradialis TrPs and elbow-related functional status was consistently demonstrated across the OES domains. Workers with TrPs had lower elbow-function, pain, and social–psychological scores than those without TrPs. The largest absolute domain difference was observed for elbow pain, while the overall mean OES difference was approximately 21 points.

These findings suggest that localized brachioradialis tenderness may coexist with a broader pattern of elbow-related symptoms and limitations in daily activities. Kim described brachioradialis-related pain as an often underrecognized source of forearm discomfort that may be mistaken for lateral epicondylitis or other upper-extremity conditions (17). The overlap in symptom location and functional presentation is clinically important because lateral forearm pain may arise from several muscular, tendinous, or neural structures.

The item-level findings provide further insight into the functional limitations reported by the participants. Difficulty carrying shopping bags (40.9%) and lifting objects (40.6%) were among the most frequently reported problems, followed by usual elbow pain (39.0%). These activities commonly require coordinated elbow stabilization and sustained gripping effort. In contrast, washing and dressing were less frequently affected. This pattern is compatible with the mechanical demands of the respective activities, although the study did not directly assess task-specific muscle activation or the relationship between individual occupational tasks and OES responses.

The relationship between upper-extremity musculoskeletal problems and occupational functioning has been demonstrated in previous research. Van Schaaijk et al. found that limitations in daily activities and gripping tasks were associated with self-reported work ability and hours worked among individuals with upper-extremity musculoskeletal disorders (25). Nambiema et al. also identified contributions of occupational and personal factors to upper-extremity musculoskeletal disorders in a working population (26). These findings support the potential occupational relevance of pain-related upper-limb limitations. However, the present study did not directly measure absenteeism, productivity, work ability, or occupational disability, so no conclusions regarding these outcomes can be drawn.

The high OES scores among workers without TrPs and the concentration of overall OES values near the maximum also deserve attention. The OES was originally developed for evaluating elbow-related health and disability, and its application in a general occupational population may produce ceiling effects when many individuals have relatively preserved elbow function. Such effects can reduce discrimination among participants with minimal symptoms and complicate interpretation of differences in otherwise healthy populations. The observed group differences should therefore be interpreted alongside the instrument's measurement properties and its use outside a specifically diagnosed elbow-disorder population.

Diagnostic and Clinical Implications

The findings suggest that brachioradialis examination may contribute useful clinical information when evaluating workers presenting with lateral forearm pain, reduced gripping performance, or difficulty performing repetitive upper-limb activities. In particular, recognition of localized muscular tenderness may complement assessment of tendinous, articular, and neurological causes of elbow-related symptoms.

Diagnostic overlap represents an important consideration. Kim emphasized that brachioradialis pain can resemble lateral epicondylitis and other disorders of the elbow and forearm (17). In an occupational investigation, Yoon et al. found that estimates of lateral epicondylitis prevalence varied according to the clinical case definition applied, emphasizing the influence of examination criteria on diagnostic classification (27). Similarly, Li et al. identified substantial variation in the diagnostic criteria used for myofascial TrPs across physical therapy trials (13).

Together, these findings highlight the importance of standardized examination procedures and cautious diagnostic interpretation. Palpation-based identification of TrPs should not be regarded as definitive evidence of a distinct

disorder in isolation, particularly when alternative diagnoses may explain similar symptoms. The present findings support including brachioradialis assessment within a broader clinical examination rather than using TrP identification as a substitute for differential diagnosis.

There is also growing evidence concerning the treatment of myofascial dysfunction in lateral elbow pain populations. Navarro-Santana et al., in a systematic review and meta-analysis, reported improvements in pain, disability, pressure pain sensitivity, and grip strength following trigger-point dry needling in patients with lateral epicondylalgia (28). More recently, Ma et al. conducted an updated systematic review and meta-analysis investigating dry needling for lateral epicondylitis (29). Shanmugam et al. additionally examined dry needling combined with eccentric strengthening among individuals with lateral epicondylalgia and TrPs, reporting short-term functional improvements without sustained between-group differences at the 12-week follow-up (30).

Although these studies indicate that myofascial interventions have been investigated in symptomatic lateral elbow populations, their findings cannot establish treatment effectiveness among asymptomatic or undiagnosed factory workers with palpated brachioradialis TrPs. The present investigation was observational and did not evaluate any therapeutic intervention. Accordingly, treatment recommendations should depend on clinical assessment and appropriate interventional evidence rather than the associations identified here.

Occupational Health and Preventive Considerations

The findings have potential implications for occupational musculoskeletal surveillance in industries requiring repetitive upper-limb activity. Routine evaluation of forearm symptoms, grip performance, and task-related functional difficulties may help identify workers who could benefit from further musculoskeletal assessment. Ergonomic considerations such as tool design, workstation arrangement, repetitive force requirements, recovery opportunities, and task organization may also be relevant.

Bao et al. identified high repetition and pinch-force demands among biomechanical factors associated with hand and wrist musculoskeletal disorder claims in manufacturing workplaces (5). Keir et al. further summarized evidence linking occupational force, repetition, posture, and vibration with distal upper-extremity disorders (6). These findings reinforce the importance of addressing multiple occupational exposures rather than attributing symptoms solely to localized muscular abnormalities.

Nevertheless, the present investigation did not quantify ergonomic exposures or test preventive interventions. Therefore, recommendations concerning scheduled rest periods, task rotation, workstation modification, or ergonomic education should be viewed as general occupational health considerations supported by the wider literature, not as interventions demonstrated to reduce brachioradialis TrPs in this study.

Strengths and Limitations

The study has several methodological strengths. It included a relatively large sample of 374 industrial workers and examined a specific forearm muscle that has received comparatively limited attention in occupational musculoskeletal research. Both forearms were assessed, enabling documentation of unilateral and bilateral TrP distribution. Handgrip performance was measured with an electronic dynamometer, and elbow-related pain and functional limitations were assessed using a structured patient-reported outcome instrument. The simultaneous evaluation of TrP prevalence, anatomical distribution, grip-strength classification, and OES domains provided a multidimensional description of the clinical and functional characteristics of the study population.

Several limitations must be considered when interpreting the findings. First, the cross-sectional design prevents determination of temporal relationships and causal direction. Reduced grip strength and elbow-related functional limitations may be associated with TrPs, but reverse relationships or shared contributing factors cannot be excluded. Second, recruitment was limited to sports goods and surgical instrument factories in a single industrial city, using convenience sampling. Consequently, selection bias is possible, and the observed prevalence cannot be assumed to represent all workers in Sialkot, other manufacturing industries, or the general population. Third, although both sexes were eligible, the final sample included only men aged 20–40 years. The findings therefore cannot be generalized directly to female workers, older employees, or occupational groups with different physical demands.

Fourth, TrPs were identified using clinical palpation, which depends partly on examiner judgment and participant-reported tenderness. Although two trained examiners performed the assessments, interexaminer agreement statistics were not reported. Variation in clinical diagnostic criteria and examination reliability may influence prevalence estimates (13,14). Fifth, handgrip strength was analyzed as a categorical variable rather than through continuous dynamometer values. Categorization may reduce information and sensitivity, particularly when strength varies with age, body dimensions, occupation, and hand dominance. The precise normative threshold underlying the normal/reduced classification also requires explicit methodological documentation. Sixth, the study did not distinguish active from latent TrPs. Therefore, it was not possible to determine whether spontaneous pain-producing TrPs and pressure-sensitive latent TrPs were differently associated with grip strength or OES outcomes. Seventh, relevant occupational and individual factors, including hand dominance, repetition frequency, applied force, posture, tool characteristics, and other musculoskeletal symptoms, were not comprehensively assessed. Furthermore, the statistical analyses were unadjusted, leaving the possibility of residual confounding. Finally, the OES was applied to an occupational population rather than exclusively to patients with diagnosed elbow disorders. The concentration of scores near the scale maximum suggests a potential ceiling effect, and the clinical interpretation of observed score differences requires caution.

Recommendations for Future Research

Future research should evaluate brachioradialis TrPs in more diverse occupational populations, including women, older workers, and employees from other manufacturing settings. Multicentre investigations using probability-based sampling could improve the representativeness of prevalence estimates.

Longitudinal studies would be particularly valuable for establishing whether the presence or development of brachioradialis TrPs precedes changes in grip strength, elbow pain, or functional performance. Studies incorporating objective ergonomic exposure assessments could further evaluate associations with repetition rate, force requirements, sustained posture, work duration, hand dominance, and recovery periods. Future investigations should consider standardized trigger-point examination criteria, interexaminer reliability assessment, differentiation between active and latent TrPs, and complementary quantitative measurements such as pressure pain thresholds or musculoskeletal ultrasound where appropriate. Grip strength should preferably be retained as a continuous variable, with clearly defined measurement protocols and consideration of relevant individual characteristics.

Multivariable analyses adjusting for occupational and demographic confounding factors would strengthen interpretation of independent associations. Finally, controlled interventional studies could evaluate whether targeted rehabilitation, exercise, ergonomic modification, or combined occupational health approaches improve pain, grip performance, and functional outcomes among workers with clinically identified brachioradialis TrPs. Overall, the present investigation identifies a substantial prevalence of brachioradialis TrPs in the sampled male industrial workforce and demonstrates their association with reduced grip-strength classification and poorer elbow-related functional status. These findings support further investigation of brachioradialis involvement in occupational upper-limb assessment while emphasizing the need for stronger longitudinal, diagnostic, and interventional evidence.

CONCLUSION

Brachioradialis myofascial trigger points were identified in 44.9% of the 374 male factory workers examined in Sialkot, Pakistan. Their presence was significantly associated with reduced handgrip-strength classification, greater elbow-related pain, and lower functional and social–psychological Oxford Elbow Scores. Workers with trigger points exhibited a substantially higher frequency of reduced grip strength and poorer overall elbow-related functional status than those without trigger points. These findings indicate that brachioradialis assessment may provide useful complementary information during the evaluation of upper-limb symptoms in workers performing repetitive manual activities. However, the cross-sectional design, convenience sampling, and absence of confounder-adjusted analyses preclude causal interpretation. Further longitudinal and interventional studies are required to establish temporal relationships and determine whether targeted clinical or occupational interventions improve functional outcomes.

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