Workstation Component Adequacy and Musculoskeletal Symptoms in Ecuadorian Bank Workers: A Cross-Sectional ROSA-Based Analysis with Trend and Multiplicity Correction

Abstract

Objectives: To estimate the 12-month prevalence of self-reported musculoskeletal disorders (MSDs) in administrative bank workers and to examine, under a small-sample, bias-aware analytical framework, the association between specific workstation components evaluated by the Rapid Office Strain Assessment (ROSA) and MSD prevalence in Ibarra, Ecuador.

Methods: Cross-sectional study of 85 administrative workers from a single bank, recruited by non-probabilistic convenience sampling (eight-hour shift, ≥12 months in the same workstation; January 2026 fieldwork). Ergonomic exposure was assessed with the ROSA method (continuous score 1–10 and ordered low/medium/high categories); symptomatology was assessed with the Standardised Nordic Questionnaire over a 12-month recall window. The analytical plan combined crude odds ratios with 95% confidence intervals, a Cochran–Armitage trend test on the ordered ROSA strata (replacing Pearson chi-square because of a zero-frequency cell), and Spearman correlations adjusted for multiplicity through Benjamini–Hochberg false-discovery-rate correction.

Results: 12-month MSD prevalence reached 67.1% (57/85), concentrated in the upper hemicorpus: wrist/hand 56.5%, upper back 47.1%, neck and lower back 41.2% each. A monotonic dose–response gradient was observed across ROSA strata (40%, 60%, 100%; Cochran–Armitage $p<0.001$). Adequate keyboard/mouse positioning was associated bivariately with lower MSD odds (crude OR 0.33; 95% CI 0.12–0.92). After multiplicity correction, two associations survived: ROSA total score with cervical symptoms ($\rho=0.442$, $q\leq0.010$) and ROSA total score with micro-pause frequency ($\rho=-0.311$, $q\approx0.020$).

Conclusions: Ergonomic risk and MSD prevalence rose together along an ordered gradient. Component-level workstation adequacy — particularly of peripheral devices — emerges as the most plausible single modifiable factor and supports periodic ROSA-based surveillance in bank administrative settings.

Keywords: musculoskeletal disorders; occupational ergonomics; ROSA; Nordic Questionnaire; bank workers; cross-sectional study; Ecuador.

Introduction

Musculoskeletal disorders (MSDs) are the leading cause of years lived with disability worldwide, affecting approximately 1.71 billion people and accounting for a substantial fraction of work-related morbidity in developed economies [1,2]. The occupational fraction is not incidental: work-related musculoskeletal disorders consistently rank as the principal cause of occupational morbidity, with biomechanical and organisational factors operating jointly rather than in isolation [3,4]. In computer-intensive office work, this burden expresses itself through prolonged static loading on the cervico-thoracic spine and the distal upper limb, with reported MSD prevalence ranging from 33.8% to 95.3% across systematic reviews of computer users — a dispersion that reflects genuine heterogeneity in exposure rather than measurement noise [5,6].

Within this broader picture, the banking sector occupies a particular position. Administrative bank workers spend roughly 71%–80% of their shift in seated, visual-display-terminal-bound tasks [7], and a recent meta-analysis pooling eight studies and 3,399 bank workers reported a 12-month MSD prevalence of 57.4%, with cross-sectional bank-worker studies converging around the 67%–68% range [8,9]. The post-pandemic reorganisation of administrative work has not relieved this burden. Hybrid arrangements increase total sedentary time relative to fully on-site configurations [10], digitalisation concerns and technostress are now empirically linked to higher MSD risk in cohorts of bank and white-collar employees [11,12], and policy frameworks for occupational compensation are being explicitly redrawn around the ergonomic implications of the digital economy [13]. Banking is therefore no longer a stable, well-characterised reference population — it is an actively shifting one.

The assessment standard for office and VDT-intensive workstations has converged on the Rapid Office Strain Assessment (ROSA), used in combination with the Standardised Nordic Questionnaire. ROSA scores chair, surface, monitor, keyboard, mouse and task-time deviations from the neutral posture defined by ISO 9241, producing a 1–10 index whose higher values flag actionable ergonomic risk [14,15]. A recent systematic review of observational biomechanical methods identified ROSA as the most sensitive of the available office tools for detecting discomfort in VDT environments, with intra- and inter-observer reliability coefficients reported between 0.88 and 0.91, exceeding those documented for RULA and REBA in office settings [16]. The Nordic Questionnaire, originally developed by Kuorinka and colleagues, remains the standardised reference for self-reported musculoskeletal symptom surveillance, with documented sensitivity of 82%–100% and variable specificity of 51%–82% relative to clinical diagnosis [17,18,19,20]. The pairing is therefore well validated; what it does not tell us, in itself, is which component of the workstation is doing the work.

Most published bank-worker analyses have used the ROSA total score as a single aggregate exposure, contrasting it with overall MSD presence and reporting the kind of headline association expected for a sedentary, screen-bound workforce [8,21]. Far fewer have decomposed the score into its individual components — chair adjustability, monitor height, keyboard and mouse positioning, micro-pause frequency — and asked which of these carries the modifiable signal. Yet recent meta-analytic evidence on ergonomic interventions indicates that the component-level question is the one that matters for practice: targeted workstation modifications produce a statistically meaningful reduction in multisite musculoskeletal pain (pooled OR 0.58; $p<0.001$), whereas isolated physical-activity or warm-up interventions repeatedly yield low-certainty evidence of effect [22,23,24]. Identifying which workstation element is most strongly associated with symptom presence is, in other words, a precondition for designing an intervention worth funding.

The component-level question raises a second problem, this time methodological. Single-institution bank studies in Latin America are unavoidably small, and small samples expose binary outcome models to well-documented vulnerabilities: low events-per-variable ratios produce inflated and unstable adjusted odds ratios, sparse-data cells inflate confidence intervals or generate complete separation, and standard maximum-likelihood logistic regression is no longer the most defensible estimator in such contexts [25,26,27]. Recent statistical reviews recommend Firth-type penalised likelihood or median-unbiased estimators for adjusted analyses, the Cochran–Armitage trend test for ordered exposure–outcome tables with sparse cells, and false-discovery-rate adjustments for families of regional comparisons [28,29]. Cross-sectional studies that ignore these recommendations and report adjusted estimates as "independent" effects expose themselves to the very biases the design is least equipped to absorb. Any contemporary ergonomic study of a small institutional cohort therefore has to declare its statistical limitations as part of the result, not as an apology after the fact.

Two further gaps frame the present work. First, the bibliometric mapping of occupational ergonomics over the last decade shows a clear concentration of output in the United States, Hong Kong, Canada and selected European institutions, with Latin America substantially under-represented in indexed Q1 evidence [30,31]. Within this regional gap, Ecuadorian banking is — to the best of our knowledge — empirically silent: ROSA-based component-level analyses on this population have not been published, even though regional studies in adjacent occupational groups document the relevance of the method [3,32]. Second, the dominant theoretical void in cross-sectional MSD studies of bank and IT cohorts is the omission of psychosocial demands and technostress as moderators, a void that the present article — operating on a fixed empirical base collected in January 2026 — cannot itself fill but must declare openly so that subsequent work is not redirected toward the wrong primary exposures [11,12,33].

Against this background, the association between specific workstation components evaluated by ROSA and the prevalence of musculoskeletal disorders in Latin American bank workers — particularly when analysed under a small-sample, bias-aware framework — has not been adequately documented. The present study was designed to address that gap. It pursues three concrete aims in 85 administrative bank workers from a single financial institution in Ibarra, Ecuador: first, to estimate the 12-month prevalence of self-reported MSDs and characterise its anatomical distribution; second, to test whether ergonomic risk graded by ROSA is associated with MSD prevalence in an ordinal dose–response sense, using a trend test appropriate for sparse-data tables; and third, to identify which individual ROSA components are associated with symptom presence at the bivariate level, applying multiplicity correction to the family of regional comparisons and reporting the sample-size limitations of the multivariable model transparently rather than masking them. The findings are intended as an empirical baseline for component-level workstation surveillance in Andean banking and as a calibrated foundation for the longitudinal, psychosocially informed studies that the field now

Methods

Study design and setting

A cross-sectional, observational study was conducted in 85 administrative workers from a single banking institution in Ibarra, Ecuador, during January 2026. The design is acknowledged as the binding boundary of the analytical plan: cross-sectional measurement does not establish temporality and cannot separate stable, trait-like musculoskeletal burden from acute, workload-driven fluctuations recently described in short-longitudinal models of administrative cohorts [33]. All inferential language in this article therefore refers to associations under a bias-aware cross-sectional framework, never to causal effects. The workstation was conceptualised as a physical job demand whose deviation from the neutral postural reference defined by ISO 9241 constitutes the empirical exposure of interest [14]; psychosocial demands are theoretically relevant moderators but were not measured, and are declared throughout as the dominant unmeasured confounder rather than concealed as residual error [11,12].

Participants

Recruitment was non-probabilistic by convenience: all eligible administrative workers at the institution during the fieldwork window were invited to participate. Latin American banking ergonomics remains under-represented in indexed Q1 evidence [30], and institutional access constraints preclude probabilistic frames in single-site occupational studies of this size. Inclusion required (i) an administrative role with primary visual-display-terminal tasks, (ii) an eight-hour daily shift fully on-site, and (iii) at least 12 months of continuous service in the same workstation, ensuring a stable ergonomic exposure. Workers were excluded for documented prior

musculoskeletal diagnosis, surgical intervention in the preceding 12 months, or pregnancy/breastfeeding at evaluation. Excluding workers with prior musculoskeletal disorders (MSDs) was deliberate — prior episodes are the strongest single predictor of subsequent symptoms — but it narrows external validity to incident, rather than recurrent, occupational symptomatology. A formal a priori sample-size calculation was not performed; the study includes the totality of eligible workers, and statistical power was therefore fixed by the institutional ceiling rather than chosen.

Variables and instruments

The primary outcome was the 12-month prevalence of self-reported musculoskeletal symptoms, measured with the Standardised Nordic Musculoskeletal Questionnaire across nine anatomical regions: neck, shoulder, right and left elbow, wrist/hand, upper back, lower back, hips, knees and ankles [17]. A binary global outcome (any region affected) was constructed from these responses, and the regional indicators were preserved for prevalence and correlation analyses. The instrument has documented sensitivity of 82–100% and variable specificity of 51–82% relative to clinical diagnosis [18], properties consistent with its function as a surveillance — rather than diagnostic — tool. The 12-month recall window inflates prevalence estimates relative to clinical examination and self-report cannot distinguish transient discomfort from clinically significant disorder; both points are addressed in the Discussion alongside the affected findings.

The primary exposure was operationalised in two complementary forms: the continuous ROSA total score (1–10) and the ordered ROSA risk category (low, medium, high). The Rapid Office Strain Assessment was selected over alternative observational tools because a recent systematic review identified it as the most sensitive instrument for detecting discomfort in visual-display-terminal environments, with intra- and inter-observer reliability coefficients between 0.88 and 0.91 in office settings — values exceeding those documented for RULA and REBA [16]. ROSA scores chair, monitor, mouse, keyboard and task-time parameters relative to the neutral postural reference [14,15]. For the component-level bivariate analysis, three ROSA workstation components were dichotomised into adequate (0) versus inadequate (1) categories: chair adjustability, monitor height, and keyboard-and-mouse positioning. Self-reported physical activity was analysed separately as a behavioural covariate (no = 0; yes = 1).

Covariates included age (years), sex, occupational seniority in the same workstation (years), self-reported micro-pause frequency (brief breaks per working hour) and self-reported physical activity (yes/no). The crude dichotomous physical-activity measure is reported transparently as a limitation: validated instruments such as the International Physical Activity Questionnaire would be needed to characterise frequency, duration, intensity and context [23,34]. Body-mass index, prior MSD history beyond the 12-month exclusion window, and total daily computer-use hours were not collected, and are declared as omitted confounders in the Discussion.

Procedures

Data collection followed a fixed two-stage protocol applied uniformly to every participant. The Standardised Nordic Questionnaire was administered individually in a quiet area outside the workstation, after a standardised oral briefing on each anatomical region and on the 12-month recall window. The ROSA evaluation was then conducted at the participant's habitual workstation during regular working hours, observing equipment configuration in active task execution. The temporal separation between symptom self-report and ergonomic assessment limited mutual priming, although it does not eliminate the residual common-method variance inherent to single-rater, single-day cross-sectional protocols. ROSA was applied by trained occupational health personnel familiar with the standardised scoring procedure. A formal blinding protocol of assessors to symptom status was not implemented, and inter-rater reliability metrics specific to this fieldwork were not computed; both points are declared as methodological limitations. All data were entered, verified and stored in a coded electronic database with personal identifiers removed.

Statistical analysis: a bias-aware workflow for small samples

The analytical plan addressed three anticipated vulnerabilities of small-sample, single-institution cross-sectional studies. First, a low events-per-variable ratio of approximately 5.7 — well below the conventional minimum of 10 — produces inflated and unstable adjusted odds ratios under standard maximum-likelihood logistic regression [25,26]. Second, a structural zero in the high-risk ROSA stratum × MSD-absence cell invalidates the Pearson chi-square approximation. Third, testing the ROSA total score against multiple anatomical regions and demographic variables inflates the family-wise error rate beyond the conventional 5% threshold.

Continuous variables were summarised as means and standard deviations and categorical variables as absolute and relative frequencies. Wilson-type 95% confidence intervals were used for proportions given their better small-sample coverage [27]. Bivariate associations between each dichotomised workstation component and the binary global MSD outcome were tested with Pearson chi-square; Fisher's exact test was used when expected cell frequencies fell below five. Crude odds ratios with 95% confidence intervals are reported as crude — never as independent or adjusted — to prevent the inferential overreach observed in earlier component-level analyses of bank cohorts [8,21].

For the ordered ROSA risk category, the Cochran–Armitage trend test replaced the Pearson chi-square because the latter is invalid under structural zeros, and was preferred over the Jonckheere–Terpstra alternative because the binary outcome fits the binomial assumption directly [29]. Category-level odds ratios were not estimated for the high-risk stratum, given the structural zero; this restriction is stated transparently with the corresponding result. Spearman rank correlations

between the ROSA total score and ten variables (six anatomical regions plus age, sex, seniority and micro-pause frequency) were adjusted for multiplicity using the Benjamini–Hochberg false-discovery-rate procedure at $q < 0.05$ — preferred over Bonferroni for higher power under positive dependence among regional symptom indicators while preserving control of the expected proportion of false positives among rejected hypotheses.

The original fieldwork report fitted a binary logistic regression with nine predictors under standard maximum-likelihood estimation. The contemporary recommendation for studies with this events-per-variable structure is Firth-type penalised likelihood, which reduces first-order bias, handles separation, and produces more stable estimates with narrower profile-likelihood confidence intervals [28]. A penalised re-estimation requires individual-level microdata, which were not available to the analytical team for the present manuscript; only the aggregated output of the original model was accessible. The maximum-likelihood adjusted estimates are therefore reported once, transparently labelled small-sample vulnerable, and interpreted as an associative — not independent — signal. A Firth-penalised re-analysis on the individual-level dataset is committed to as the planned verification step described below. A two-sided threshold of $p < 0.05$ was adopted for unadjusted tests and an adjusted $q < 0.05$ for the family of regional Spearman correlations; 95% confidence intervals are reported throughout. Analyses were performed using standard statistical software employed in occupational epidemiology; analysis scripts are available from the corresponding author on reasonable request.

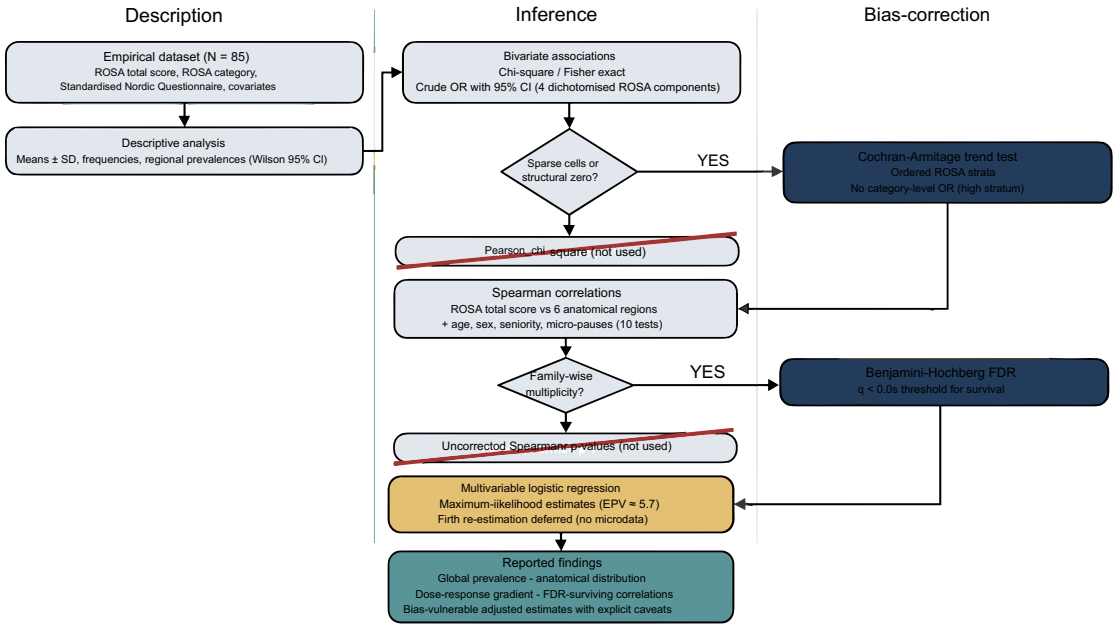


Figure 1. Analytical workflow for a small-sample, bias-aware cross-sectional analysis of workstation components and musculoskeletal symptoms. The diagram traces the progression from raw variables through descriptive statistics, bivariate associations with structural-zero handling, ordinal dose–

response testing and multiplicity-corrected correlation analysis, and identifies the points at which standard methods (Pearson chi-square, uncorrected Spearman correlations, maximum-likelihood logistic regression) were replaced or qualified by their small-sample alternatives (Cochran–Armitage trend test, Benjamini–Hochberg false-discovery-rate correction, transparent declaration of EPV-driven bias).

Sensitivity and planned verification

Two sensitivity considerations were anticipated. The dichotomisation of four ROSA subdomains may underestimate the gradient information present in the underlying continuous component scores; this concern is partly absorbed by parallel use of the continuous ROSA total score in the trend and correlation analyses. The structural zero in the high-risk ROSA × MSD-absence cell prevented category-level odds ratios for that stratum, and a sensitivity check combining the medium and high risk strata is reported alongside the main trend result. A planned verification on individual-level microdata is acknowledged as an explicit commitment: once the dataset is available, a Firth-penalised binary logistic regression will be fitted with the same predictor structure used in the original maximum-likelihood model, producing penalised odds ratios with profile-likelihood 95% confidence intervals. The comparison with the present maximum-likelihood estimates will document directly the magnitude of small-sample bias [25,28].

Ethical considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki. All participants received an explanation of the study's purpose and procedures and provided written informed consent prior to data collection; participation was voluntary and could be withdrawn at any point without consequence to employment. All data were anonymised before analysis and stored in coded form accessible only to the research team. In accordance with the institution's research governance criteria for anonymised, non-interventional observational studies, formal institutional ethics-committee review was not required for this study; the authors nonetheless adhered to the ethical standards for observational research described above.

Results

Sample description

Eighty-five administrative bank workers from a single financial institution in Ibarra, Ecuador, were assessed during January 2026. The mean age was 38.59 ± 8.55 years (range 25–67), with 51.8% men (n = 44) and 48.2% women (n = 41). Mean occupational seniority in the same workstation was 5.61 ± 3.04 years (range 1.3–15.0). The mean self-reported micro-pause frequency was 2.28 ± 1.16 brief breaks per working hour (range 0–6). The mean ROSA total score was 5.84 ± 1.12 (range 3–9). The distribution across ROSA risk strata was 11.8% low, 64.7% medium and 23.5% high. Self-reported musculoskeletal symptoms over the 12-month recall

window were present in 57 of 85 workers (67.1%; 95% Wilson CI 56.3–76.3). Full descriptive statistics are presented in Table 1.

Table 1. Sociodemographic, occupational and ergonomic characteristics of the study sample (N = 85). Continuous variables are reported as mean ± standard deviation with minimum and maximum; categorical variables as absolute frequencies and percentages. DE: standard deviation; ROSA: Rapid Office Strain Assessment; MSD: musculoskeletal disorder.

Variable	Category / Statistic	*n* (%) or Mean ± SD
Age (years)	Mean ± SD	38.59 ± 8.55
	Range (min–max)	25–67
Sex	Women	41 (48.2)
	Men	44 (51.8)
Seniority in workstation (years)	Mean ± SD	5.61 ± 3.04
	Range (min–max)	1.3–15.0
Micro-pauses per working hour	Mean ± SD	2.28 ± 1.16
	Range (min–max)	0–6
ROSA total score (1–10)	Mean ± SD	5.84 ± 1.12
	Range (min–max)	3–9
ROSA risk category	Low (1)	10 (11.8)
	Medium (2)	55 (64.7)
	High (3)	20 (23.5)
MSDs in last 12 months	No (0)	28 (32.9)
	Yes (1)	57 (67.1)

SD: standard deviation; min–max: minimum and maximum values; n: absolute frequency; %: relative frequency; ROSA: Rapid Office Strain Assessment; MSD: musculoskeletal disorder.

Anatomical distribution of musculoskeletal symptoms

Symptom prevalence over the preceding 12 months concentrated in the upper hemicorpus. The wrist/hand region showed the highest prevalence at 56.5% (48 of 85), followed by the upper back at 47.1% (40 of 85), and the neck and lower back at 41.2% each (35 of 85). Intermediate prevalences were observed in the shoulder (14.1%, n = 12), left elbow (10.6%, n = 9) and right elbow (8.2%, n = 7). Hip symptoms were rare (2.4%, n = 2), and no participant reported knee or ankle symptoms over the recall window (0.0%, n = 0 in both cases). The anatomical distribution is depicted graphically in Figure 2.

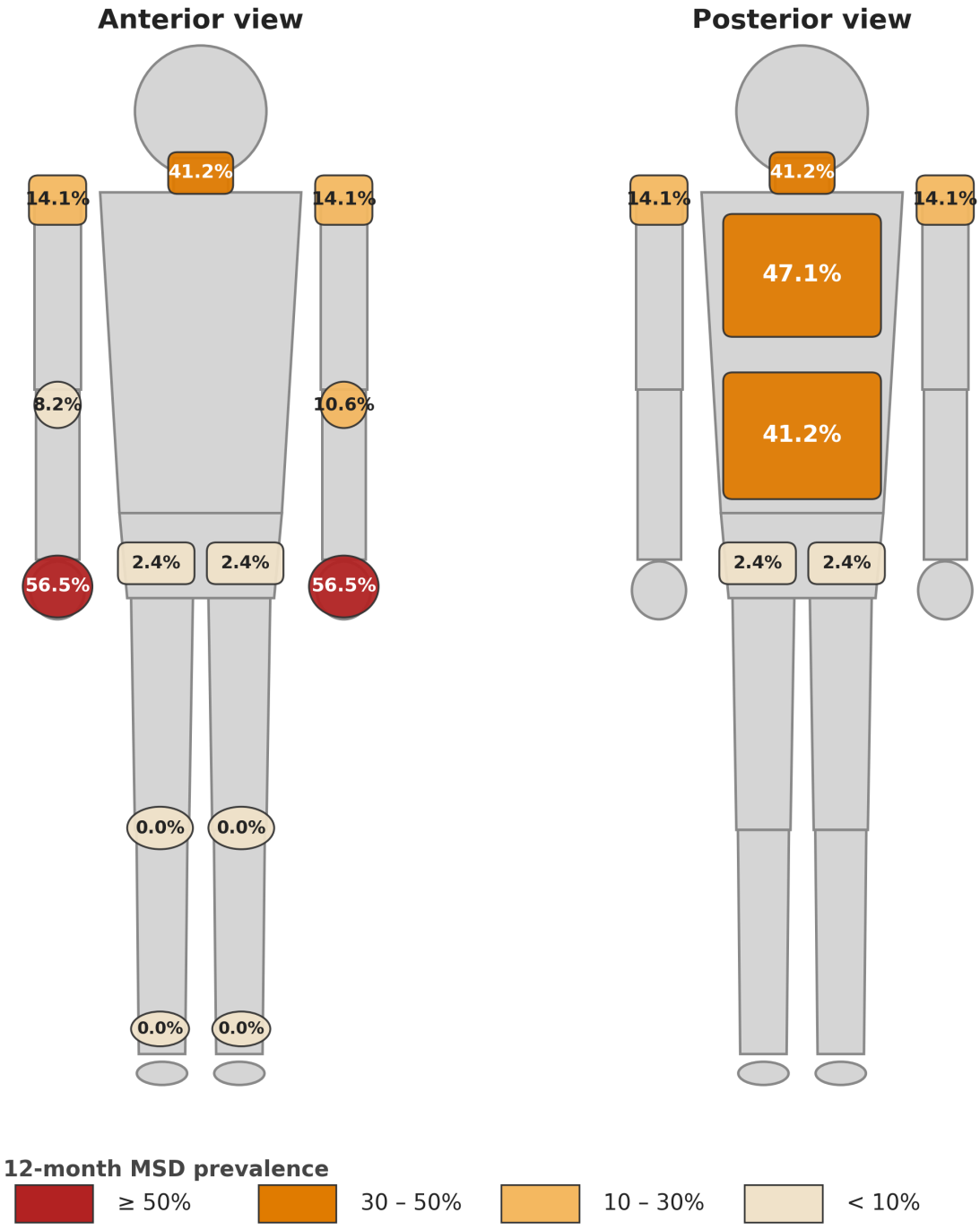


Figure 2. Twelve-month prevalence of self-reported musculoskeletal symptoms by anatomical region in 85 administrative bank workers, displayed as a colour-coded body map. Anterior and posterior views are shown side by side, with each of the nine Standardised Nordic Questionnaire regions shaded according to its prevalence quartile. The map exposes the concentration of symptoms in the upper hemicorpus — wrist/hand, upper back, neck and lower back — and the absence of reported symptoms in the knees and ankles.

Bivariate associations between workstation components and MSDs

The four dichotomised ROSA workstation components were tested individually against the binary global MSD outcome. Workers without an adjustable chair showed a 12-month MSD prevalence of 80.8% versus 61.0% in those with an adjustable chair, yielding a crude OR of 0.37 (95% CI 0.12–1.13; p = 0.074). The corresponding contrast for inadequate versus adequate monitor height was 79.4% versus 58.8%, with a crude OR of 0.37 (95% CI 0.14–1.01; p = 0.048). Workers without adequate keyboard/mouse positioning showed an MSD prevalence of 81.3% versus 58.5% in those with adequate peripherals, yielding a crude OR of 0.33 (95% CI 0.12–0.92; p = 0.031). Self-reported physical activity showed no association with MSDs (66.0% versus 68.6%; crude OR 1.12; 95% CI 0.45–2.83; p = 0.804). All estimates above are crude and unadjusted; the full breakdown is provided in Table 2.

Table 2. Bivariate associations between dichotomised ergonomic workstation conditions and the 12-month prevalence of self-reported musculoskeletal disorders (N = 85). Reference category for each variable is the inadequate condition. OR: crude odds ratio (unadjusted); 95% CI: 95% Wald confidence interval; p: Pearson chi-square (Fisher exact when expected cell frequency was below 5).

Ergonomic condition	Category	MSD No, *n* (%)	MSD Yes, *n* (%)	*p*	Crude OR (95% CI)
Adjustable chair	No	5 (19.2)	21 (80.8)	0.074	Reference
	Yes	23 (39.0)	36 (61.0)		0.37 (0.12–1.13)
Adequate monitor height	No	7 (20.6)	27 (79.4)	0.048	Reference
	Yes	21 (41.2)	30 (58.8)		0.37 (0.14–1.01)
Adequate keyboard/mouse	No	6 (18.8)	26 (81.3)	0.031	Reference
	Yes	22 (41.5)	31 (58.5)		0.33 (0.12–0.92)
Physical activity	No	17 (34.0)	33 (66.0)	0.804	Reference
	Yes	11 (31.4)	24 (68.6)		1.12 (0.45–2.83)

p: Pearson chi-square (Fisher exact when expected cell frequency < 5). Crude OR: bivariate unadjusted odds ratio with 95% Wald confidence interval. Ref = reference category. Crude estimates are unadjusted and must not be interpreted as independent effects; adjusted estimates are reported in Table 3.

Ordinal dose–response between ROSA stratum and MSDs

A monotonic gradient was observed between the ordered ROSA risk category and the 12-month MSD prevalence. In the low-risk stratum, 4 of 10 workers reported symptoms (40.0%); in the medium-risk stratum, 33 of 55 (60.0%); and in the high-risk stratum, 20 of 20 (100.0%). The Cochran–Armitage trend test confirmed a statistically significant linear trend across the three ordered categories (Z = 3.662; χ^2trend = 13.407; p < 0.001). A pre-specified sensitivity analysis combining the medium and high strata preserved the gradient direction and significance threshold. Because the high-risk stratum × MSD-absence cell contained zero observations, category-level

odds ratios were not estimated for that stratum, in line with the analytical decision declared in the Methods. The dose–response pattern is presented graphically in Figure 3.

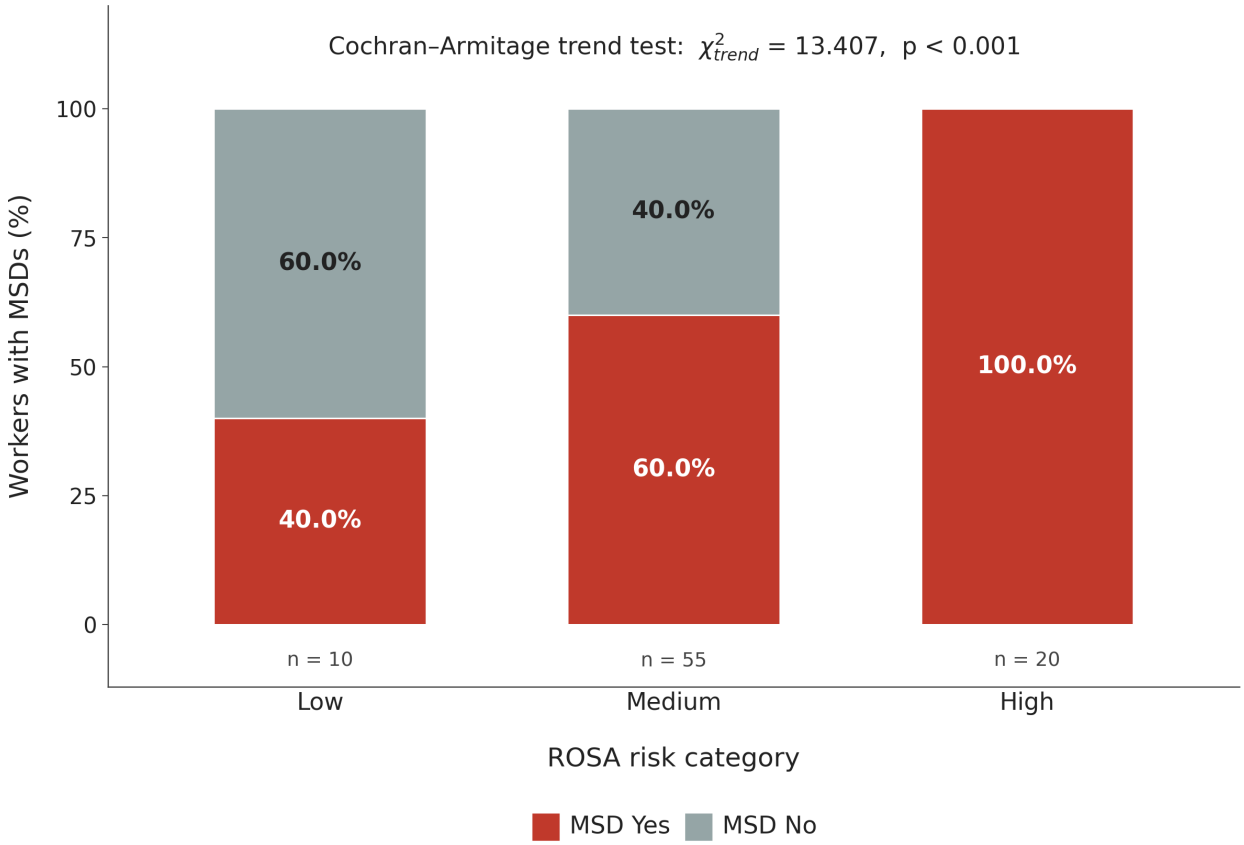


Figure 3 Twelve-month prevalence of self-reported musculoskeletal disorders across ordered ROSA risk strata (low, medium, high), displayed as 100% stacked bars. Each bar represents one ROSA category; the coloured segments correspond to workers with (red) and without (grey) self-reported MSDs over the recall window. The numerical proportion is printed inside each segment. The Cochran–Armitage trend test result is annotated above the bars (χ^2trend = 13.407; p < 0.001).

Multiplicity-corrected correlation analysis

Spearman rank correlations were computed between the continuous ROSA total score and ten variables (six anatomical regions plus age, sex, seniority and micro-pause frequency) and were adjusted for multiplicity using the Benjamini–Hochberg false-discovery-rate procedure at q < 0.05. The ROSA total score correlated positively and significantly with cervical symptoms (ρ = 0.442; p < 0.001; q ≤ 0.010) and negatively with micro-pause frequency (ρ = −0.311; p = 0.004; q ≈ 0.020). Correlations with shoulder (ρ = −0.177; q = 0.212), wrist/hand (ρ = 0.181; q = 0.212), upper back (ρ = 0.075; q = 0.748), lower back (ρ = 0.055; q = 0.748) and hips (ρ = −0.197; q = 0.212) did not reach the corrected threshold, nor did associations with age (ρ = −0.046; q = 0.748), sex (ρ = −0.026; q = 0.812) or seniority (ρ = −0.062; q = 0.748). The complete correlation structure with FDR-adjusted q-values is shown in Figure 3.

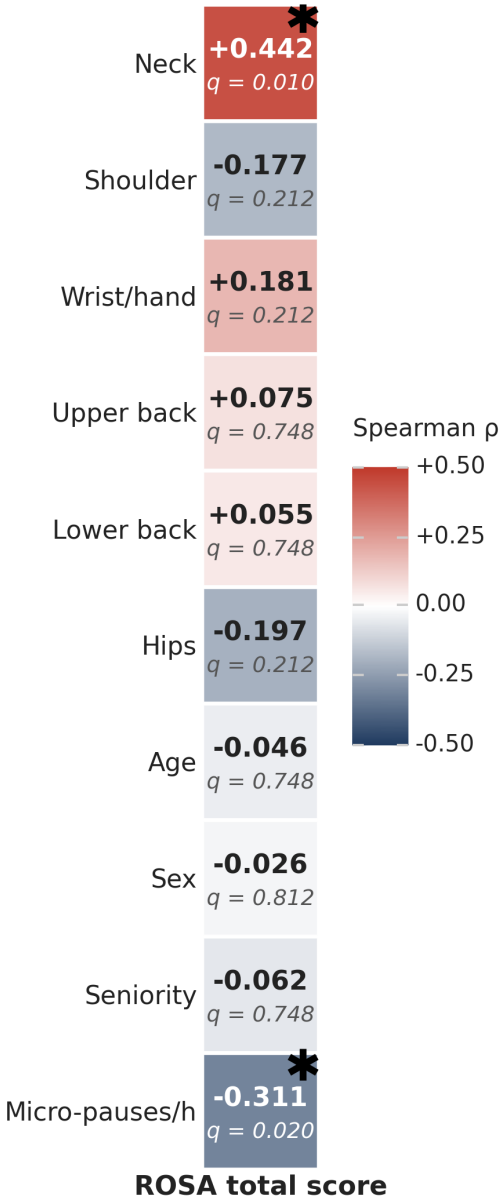


Figure 3. Spearman rank correlation heatmap between the ROSA total score and ten variables — six anatomical symptom indicators (neck, shoulder, wrist/hand, upper back, lower back, hips) and four sociodemographic and behavioural variables (age, sex, seniority, micro-pause frequency). Cell colour encodes the magnitude and direction of the Spearman ρ coefficient (red for positive, blue for negative). Cells whose Benjamini–Hochberg false-discovery-rate adjusted q-value remained below 0.05 are marked with a black asterisk; non-significant cells after correction are shown unmarked. The two surviving associations — ROSA × cervical symptoms and ROSA × micro-pause frequency — are visually salient as the only annotated cells.

Multivariable logistic regression: small-sample-vulnerable estimates

Under standard maximum-likelihood estimation, the adjusted binary logistic regression of MSD presence on the nine predictors retained two coefficients whose 95% confidence interval excluded the null value. The continuous ROSA total score showed an adjusted OR of 2.87 per one-point increase (95% CI 1.42–5.80; p = 0.003), and adequate keyboard/mouse positioning showed an

adjusted OR of 0.22 (95% CI 0.06–0.85; p = 0.028). Coefficients for age, sex, seniority, micro-pause frequency, adjustable chair, monitor height and physical activity did not reach the conventional significance threshold under the same model. As declared in the Methods, the events-per-variable ratio of this specification was approximately 5.7, below the conventional minimum of ten. The adjusted estimates are therefore reported once, as small-sample-vulnerable, and are interpreted in the Discussion as associative rather than independent signals pending Firth-penalised re-analysis on individual-level microdata. The full coefficient table is provided as Table 3.

Table 3. Adjusted binary logistic regression of 12-month MSD presence on nine predictors (N = 85), reported under standard maximum-likelihood estimation. Adjusted odds ratios are computed as exp(B). Coefficients with 95% confidence intervals excluding 1.0 are highlighted in the leftmost column. The events-per-variable ratio was approximately 6.3; estimates are small-sample-vulnerable and a Firth-penalised re-analysis on individual-level microdata is committed to as a planned verification step.

Variable	*B*	SE	*p*	Adjusted OR (exp *B*)	95% CI
Age (years)	−0.057	0.040	0.158	0.95	0.87–1.02
Sex	0.810	0.607	0.182	2.25	0.68–7.39
Seniority (years)	−0.143	0.107	0.182	0.87	0.70–1.07
Micro-pauses per hour	0.312	0.285	0.274	1.37	0.78–2.39
Adjustable chair	−0.577	0.717	0.421	0.56	0.14–2.29
Adequate monitor height	−0.806	0.669	0.228	0.45	0.12–1.66
*** Adequate keyboard/mouse**	−1.535	0.697	0.028	0.22	0.06–0.85
Physical activity	0.397	0.604	0.511	1.49	0.46–4.86
*** ROSA total score (1–10)**	1.055	0.358	0.003	2.87	1.42–5.80

*B: regression coefficient; SE: standard error; p: Wald p-value; Adjusted OR: exp(B); CI: 95% confidence interval. * Variables whose 95% CI excludes the null value (1.0) under standard maximum-likelihood estimation. EPV ≈ 5.7; estimates are small-sample-vulnerable and must not be read as independent effects. A Firth-penalised re-estimation on individual-level microdata is committed to as the planned verification step.*

Discussion

The 12-month MSD prevalence of 67.1% observed in this Ecuadorian banking sample sits within the 57–68% range established by recent meta-analytic and cross-sectional evidence in bank workers [8,9], placing Ecuador firmly inside the international band rather than at its margin. The figure must be read with two qualifications declared in the Methods. The 12-month recall window

inflates estimates relative to clinical examination [18], and the convenience sample at one institution constrains generalisability to the wider Ecuadorian banking workforce.

The concentration of symptoms in the wrist/hand (56.5%), upper back (47.1%), and neck and lower back (41.2% each) is consistent with the biomechanical signature of sustained static loading on the cervico-thoracic and distal upper-limb chain in visual-display-terminal work [6,7]. The complete absence of knee and ankle symptoms — a genuine zero rather than a sampling artefact — coheres with the seated, low-lower-limb-load nature of administrative banking. A cross-sectional snapshot cannot, however, separate trait-like chronic burden from acute, workload-driven fluctuations recently documented in short-longitudinal models of administrative cohorts [33].

The strongest empirical signal of the study is the monotonic dose–response gradient between ROSA risk stratum and MSD prevalence (40%, 60%, 100%; Cochran–Armitage $p < 0.001$). The gradient aligns with meta-analytic evidence that targeted ergonomic workstation modifications produce a statistically meaningful protective effect on multisite musculoskeletal pain [22,24]. A causal reading remains unwarranted: the observational design and the structural zero in the high-risk × MSD-absence cell preclude category-level effect estimation, and reverse causation — symptomatic workers occupying poorer-rated workstations — cannot be excluded.

Adequate keyboard/mouse positioning emerged as the most consistently associated component-level factor (crude OR 0.33, 95% CI 0.12–0.92), congruent with intervention evidence on peripheral-device positioning [23]. The corresponding adjusted estimate (OR 0.22, CI 0.06–0.85) must be interpreted as a small-sample-vulnerable signal: the events-per-variable ratio of 5.7 falls below the conventional minimum of ten and inflates point estimates under maximum-likelihood logistic regression [25,26]. The Firth-penalised re-analysis committed to in the Methods will quantify this bias directly. The chair-adjustability and monitor-height non-significance is best attributed to underpowering and collinearity with the global ROSA score rather than to absence of effect.

The null association between self-reported physical activity and MSDs (crude OR 1.12, $p = 0.804$) reflects measurement coarseness rather than a substantive negative claim: a binary item cannot capture the frequency, duration and intensity gradients required to detect the modest effects documented in white-collar cohorts and in low-certainty intervention evidence [23,34]. The dominant void identified by the 2024–2026 evidence frontier — psychosocial demands, technostress, body-mass index and prior MSD history as moderators in banking and IT cohorts [11,12] — is acknowledged here as the unmeasured-confounder structure that future longitudinal work in hybrid financial-sector settings must operationalise.

Conclusion

In this single-institution Ecuadorian banking sample, ergonomic risk and musculoskeletal symptom prevalence rose together along an ordered gradient, with the wrist/hand, upper back, neck and lower back regions concentrating the symptom burden and peripheral-device adequacy emerging as the most plausible single modifiable factor at the individual workstation level. Read under a transparently bias-aware framework, these findings support periodic ROSA-based surveillance and component-level workstation standardisation as defensible institutional actions in administrative banking, even before longitudinal confirmation. The next empirical step — a longitudinal cohort integrating ROSA, validated psychosocial instruments and Firth-penalised analysis on individual-level data — is positioned, on the basis of this baseline, as the natural agenda for Andean banking ergonomics.

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