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Dynamics of Neck Pain Intensity and Postural Control in Office Workers: A Week-long Study of Movement Variability

Eduarda Oliosi[1,2,5], Afonso Júlio[1], Luís Silva[1], Phillip Probst[1], João Paulo Vilas-Boas[2,3], Hugo Gamboa[1] and Ana Rita Pinheiro[4]

[1]*Laboratory for Instrumentation, Biomedical Engineering and Radiation Physics (LIBPhys), NOVA School of Science & Technology, NOVA University Lisbon, Caparica, Portugal*

[2]*Research Centre in Physical Activity, Health, and Leisure (CIAFEL), Faculty of Sport, University of Porto, Porto, Portugal*

[3]*Centre for Research, Training, Innovation, and Intervention in Sport (CIFI2D) and Porto Biomechanics Laboratory (LABIOMEP), Faculty of Sport, University of Porto, Porto, Portugal*

[4]*Institute of Biomedicine (iBiMED), School of Health Sciences, University of Aveiro, Aveiro, Portugal*

[5]*Value for Health (V4H), Collaborative Laboratory, Lisbon, Portugal*

up202002726@up.pt , jpvb@fade.up.pt, {a.julio, p.probst}@campus.fct.unl.pt, {lmd.silva, hgamboa}@fct.unl.pt, anaritapinheiro@ua.pt

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1 Background

Neck pain is prevalent among office workers, particularly those in sedentary roles with limited biomechanical variation and movement diversity [1], [2]. Prolonged sitting and reduced movement variability are recognized contributors to musculoskeletal discomfort, potentially indicating early-stage pain linked to biomechanical loading on the musculoskeletal system [1], [3]. This study investigates the relationship between neck pain intensity and trunk postural control dynamics in public administration workers, with real-time analysis of movement patterns across different times of day and throughout the workweek (Days 1, 3, and 5).

2 Materials and Methods

This study, part of the PrevOccupAI project to prevent occupational disorders in public administration, was conducted at the Portuguese Tax and Customs Authority in Lisbon. It was approved by the Ethics Committee of Universidade Nova de Lisboa (CE/FCT/005/2022), and all participants provided informed consent. Protocol details are in a prior publication [4].

Sixteen participants (68.8% female, mean age 53 years, BMI 27.5 kg/m²) were included, averaging 19.3 years of professional experience while working 39 hours per week.

Physical activity levels were assessed using the International Physical Activity Questionnaire Short Form (IPAQ-SF). Neck pain intensity was measured before and after work using the Numeric Pain Rating Scale (NPRS) through a project-specific app. Scores were recorded on Days 1, 3, and 5 during both morning (AM) and afternoon (PM) sessions. Motor biosignals were collected with inertial sensors mounted on a smartphone at the sternum. Linear metrics included center of pressure (COP) displacement features in the anteroposterior (AP) and mediolateral (ML) directions. Nonlinear metrics, such as sample entropy (SaEn) and the Hurst exponent, were used to evaluate the complexity of postural control (detailed in [2]). COP displacement reflects shifts in body weight, indicating forward-backward and side-to-side trunk sway. To examine relationships between neck pain and COP dynamics, Pearson correlation

coefficients (r) were calculated with statistical significance set at $p < 0.05$. Friedman's test was used to compare pain intensity due to the non-normal distribution of the data. NPRS scores were the dependent variables, while COP features were the predictor variables.

3 Results and Discussion

Physical activity levels among participants were categorized as low (31.3%), moderate (43.8%), and high (25%). Participants reported sitting approximately nine hours on weekdays and four hours on weekends. The temporal analysis of neck pain intensity showed no statistically significant differences across days or times ($p>0.05$), indicating no clear temporal pattern in pain variation. Mean pain values showed a slight hierarchical trend: pain intensity averaged 0.88 ± 1.93 on Monday morning, decreasing to 0.69 ± 1.58 on Wednesday and 0.69 ± 1.54 on Friday mornings. Afternoon scores averaged 0.75 ± 2.05 on Monday, 0.75 ± 1.65 on Wednesday, and 0.75 ± 1.73 on Friday. Pain intensity ranged from 0 to 6, suggesting individual variability without a consistent group-wide pattern.

Significant moderate correlations ($p<0.05$) were identified between pain intensity and movement features, particularly during the AM sessions on Day 1. Higher pain intensity correlated negatively with overall sway range (r =-.622) and sway range in the AP direction (r =-.613), indicating that greater pain is associated with reduced postural sway. Additionally, positive correlations were observed between pain intensity and postural control complexity, as reflected by increased SaEn in both the AP (r =.528) and ML (r =.526) directions. In the PM sessions on Day 1, significant correlations also emerged between pain intensity and mean acceleration in the AP direction (r =-.531), root mean square sway in the AP direction (r =.507), and sway area (r =.508). These findings suggest a shift in movement patterns from morning to afternoon, likely influenced by manifestations like adaptation to muscle fatigue or feeling pain [3]. However, on Days 3 and 5, no significant correlations were observed in the morning or afternoon sessions, and other parameters assessed did not reveal significant correlations.

5 Conclusions

The study identified a moderate correlation between low-intensity pain and postural control, with mild morning pain associated with reduced sway and increased postural complexity, potentially reflecting compensatory motor adjustments. Significant shifts in movement strategies were also observed during afternoon work sessions. Further research with larger, more diverse cohorts is recommended to clarify the relationship between pain intensity and motor control dynamics. Future investigations should encompass a broader spectrum of pain intensities to inform ergonomic interventions to enhance workplace health.

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