Prevalence, Risk Factors, and Nursing-Led Ergonomic Education for Wrist Soft Tissue Injuries Among Computer Science Students

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1 Introduction

Wrist soft tissue injuries are among the most frequently reported musculoskeletal disorders associated with prolonged computer use. These injuries involve damage to tendons, ligaments, muscles, and surrounding connective tissues of the wrist without the presence of fractures, and are commonly attributed to repetitive movements, sustained static postures, and suboptimal ergonomic conditions (Shahabpour et al., 2021; Wahlström, 2005). With the increasing reliance on digital technologies in higher education, university students—particularly those enrolled in computer science programs—represent a population at elevated risk.

Computer science students typically engage in extended periods of keyboard and mouse use, often exceeding six hours per day, which places continuous mechanical load on the wrist and hand structures. Repetitive flexion–extension movements, forceful gripping, and prolonged deviation from neutral wrist posture have been shown to increase intra-carpal pressure and tendon friction, contributing to conditions such as tendonitis, tenosynovitis, and carpal tunnel syndrome (CTS) (Rempel et al., 1998; Keir and Rempel, 2007). CTS, in particular, results from compression of the median nerve within the carpal tunnel and is associated with pain, numbness, tingling, and functional impairment (Atroshi et al., 2009)

Previous research has demonstrated a high prevalence of upper limb musculoskeletal symptoms among students and workers with intensive computer exposure. Studies conducted in academic settings report prevalence rates of wrist and hand discomfort ranging from 30% to 60%, with symptom severity closely linked to daily computer usage duration, workstation design, and lack of ergonomic awareness (Sanusi, 2013; Woo et al., 2016). Despite this, ergonomic education and preventive strategies are often underutilized within university health programs.

Nursing professionals play a critical role in occupational and preventive health through education, early detection, and behavior modification. Nursing-led ergonomic interventions have been shown to improve knowledge, promote healthy workstation practices, and reduce musculoskeletal symptoms in both healthcare and non-healthcare populations (Oakman et al., 2018; Ahmed et al., 2023). Structured educational programs focusing on posture correction, workstation adjustment, and scheduled breaks can significantly mitigate the risk of repetitive strain injuries.

In Egypt, limited data exist regarding wrist soft tissue injuries among university students, particularly within technology-focused disciplines. This study therefore aims to investigate the prevalence and associated risk factors of wrist soft tissue injuries among computer science students at Beni Suef University, and to evaluate the effectiveness of a nursing-led ergonomic education intervention in improving knowledge and reducing symptoms.

2 Methodology

2.1 Study Design

This study employed a quantitative methodological approach consisting of two integrated components. First, a cross-sectional descriptive design was used to estimate the prevalence of wrist soft tissue injury symptoms and to explore ergonomic and behavioral risk factors among undergraduate computer science students. Second, a quasi-experimental pre–post intervention design was applied to evaluate the effectiveness of a nursing-led ergonomic education program on pain severity, functional impairment, and ergonomic knowledge.

The cross-sectional design is appropriate for prevalence estimation and risk factor identification within a defined population, while the pre–post design allows assessment of within-subject changes following an educational intervention when randomization is not feasible in academic settings (Polit & Beck, 2021).

2.2 Study Setting

The study was conducted at the Faculty of Computer Science, Beni Suef University, Egypt. All stages of data collection and intervention delivery were implemented online to ensure accessibility, standardization, and ease of participation.

2.3 Study Population

The target population consisted of undergraduate students enrolled in the computer science program who routinely used computers for academic activities, including programming, laboratory assignments, and independent study.

2.4 Eligibility Criteria

Inclusion criteria were:

- Enrollment as an undergraduate computer science student.
- Regular computer use of at least three hours per day.
- Ability to read and complete an online questionnaire.
- Provision of informed electronic consent.

Exclusion criteria were:

- History of wrist fracture, upper limb surgery, or traumatic injury.
- Diagnosed inflammatory joint disease (e.g., rheumatoid arthritis).
- Neurological disorders affecting hand or wrist function unrelated to computer use.

These criteria were applied to reduce confounding from conditions unrelated to ergonomic exposure.

2.5 Sample Size Determination

Sample size estimation was guided by the intervention component of the study. Based on previous ergonomic education studies demonstrating moderate intervention effects on musculoskeletal outcomes, a standardized effect size of Cohen's $d = 0.5$ was assumed (Ahmed et al., 2023).

The minimum required sample size for paired-sample comparison was calculated using the following formula:

$$n = \left(\frac{Z_{\alpha/2} + Z_{\beta}}{d} \right)^2 \tag{1}$$

Where:

- $Z_{\alpha/2} = 1.96$ for a two-tailed significance level of 0.05,
- $Z_{\beta} = 0.84$ for 80% statistical power,
- $d = 0.5$ (moderate effect size).

This calculation yielded a minimum sample size of 64 participants for a single-group pre–post design. To account for attrition and to allow subgroup analysis, a total of 142 participants were recruited.

2.6 Sampling Technique

A simple random sampling technique was employed. Eligible students were invited through official academic communication channels, and participant selection was conducted using a randomization process to minimize selection bias.

2.7 Data Collection Instruments

Data were collected using a structured online questionnaire composed of the following components:

2.7.1 Demographic and Computer Usage Questionnaire

This section collected information on age, gender, body mass index (BMI), average daily computer use (hours/day), and continuous computer usage duration (minutes per session).

2.7.2 Boston Carpal Tunnel Questionnaire (BCTQ)

Wrist pain severity and functional impairment were assessed using the Boston Carpal Tunnel Questionnaire (BCTQ), a standardized and widely validated self-report instrument designed to evaluate symptoms related to carpal tunnel syndrome and wrist soft tissue disorders (Levine et al., 1993).

The BCTQ consists of two domains:

- **Symptom Severity Scale (SSS):** 11 items assessing pain intensity, frequency, numbness, tingling, weakness, nocturnal symptoms, and difficulty handling small objects.
- **Functional Status Scale (FSS):** 8 items assessing difficulty performing daily hand-related activities such as writing, gripping, and self-care.

Table 2.1: Summary of the Boston Carpal Tunnel Questionnaire (BCTQ)

Domain	**Number of Items**	**Measured Constructs**	**Scoring Range**
Symptom Severity Scale (SSS)	11 items	Pain intensity and frequency, numbness, tingling, weakness, nocturnal symptoms, and difficulty handling small objects	1 (Normal) – 5 (Very severe)
Functional Status Scale (FSS)	8 items	Difficulty performing daily hand-related activities (e.g., writing, gripping, self-care tasks)	1 (No difficulty) – 5 (Cannot perform)

Each item is scored on a five-point Likert scale ranging from 1 (no symptoms or difficulty) to 5 (very severe symptoms or inability to perform the activity). Domain scores are calculated as the mean of item responses, with higher scores indicating greater symptom severity or functional impairment.

The BCTQ demonstrates strong psychometric properties, with reported Cronbach's alpha values ranging from 0.89 to 0.93 and established construct validity across diverse populations (Levine et al., 1993; Atroshi et al., 2009).

2.7.3 Ergonomic Knowledge and Practice Checklist

Ergonomic knowledge and preventive practices were assessed using a structured checklist adapted from validated ergonomic assessment tools used in occupational health research (Woo et al., 2016; Oakman et al., 2018).

The checklist included items covering:

- Neutral wrist posture during typing and mouse use.
- Keyboard and mouse positioning.
- Monitor height and seating posture.
- Frequency of breaks and stretching exercises.

Items were scored dichotomously (correct/incorrect), and total scores were converted to a percentage scale ranging from 0 to 100. Higher scores reflected better ergonomic knowledge and practices. Internal consistency reliability was assessed in the current study using Cronbach's alpha.

2.8 Intervention: Nursing-Led Ergonomic Education Program

The intervention consisted of a structured nursing-led ergonomic education program grounded in occupational health nursing and health promotion theory, emphasizing prevention, early symptom recognition, and behavior modification (Pender et al., 2015).

The program was delivered through online interactive sessions and included:

- Education on wrist anatomy and mechanisms of repetitive strain injury.
- Instruction on proper ergonomic workstation setup.
- Demonstration of wrist stretching and strengthening exercises.
- Guidance on scheduling micro-breaks and reducing prolonged static postures.

Each session lasted approximately 45–60 minutes and was supported by visual demonstrations and digital educational materials distributed to participants.

2.9 Data Collection Procedure

Baseline data were collected prior to intervention delivery using Google Forms. Follow-up data were collected three months after the intervention using the same instruments. Online data collection ensured standardized administration, reduced data entry errors, and facilitated participant follow-up.

2.10 Statistical Analysis

Data were analyzed using JASP statistical software (version 0.18). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize participant characteristics and baseline variables.

Inferential statistical analyses included:

- Cronbach's alpha to assess internal consistency reliability of multi-item scales.
- Pearson correlation coefficients to examine associations between computer usage variables and wrist symptom severity.
- Paired-samples t-tests to compare pre- and post-intervention outcomes.
- Effect size estimation using Cohen's d for paired samples to quantify the magnitude of intervention effects.

Statistical significance was set at $p < 0.05$, and both statistical and clinical significance were considered in result interpretation (Cohen, 1988).

2.11 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of Beni Suef University. Informed consent was obtained electronically from all participants prior to data collection. Participation was voluntary, confidentiality was maintained and participants were informed of their right to withdraw at any time without academic or personal consequences.

3 Results

3.1 Baseline Characteristics

A total of 142 undergraduate computer science students participated at baseline, of whom 128 completed the three-month follow-up assessment, yielding an attrition rate of 9.9%. Baseline demographic and clinical characteristics were comparable between the intervention and control groups.

The mean age of participants was 21.5 years (SD = 2.3), and 55.6% were male. The mean body mass index (BMI) was 24.0 (SD = 3.4). Average daily computer use was 6.4

hours (SD = 1.8), with a mean continuous usage duration of 55.0 minutes (SD = 19.8). Baseline pain severity, functional impairment, and ergonomic knowledge scores did not differ meaningfully between groups, indicating baseline equivalence.

Table 3.1: Baseline Characteristics of Participants by Study Group

Characteristic	**Intervention** (n = 64)	**Control** (n = 78)	**Total** (N = 142)
Age (years), mean ± SD	21.6 ± 2.2	21.5 ± 2.4	21.5 ± 2.3
Male, n (%)	36 (56.3)	43 (55.1)	79 (55.6)
Body Mass Index, mean ± SD	23.9 ± 3.4	24.0 ± 3.5	24.0 ± 3.4
Daily computer use (hours), mean ± SD	6.4 ± 1.8	6.5 ± 1.7	6.4 ± 1.8
Continuous computer use (minutes), mean ± SD	55.3 ± 20.1	54.7 ± 19.6	55.0 ± 19.8
Baseline pain severity score, mean ± SD	2.75 ± 0.90	2.82 ± 0.90	2.79 ± 0.90
Baseline functional impairment score, mean ± SD	2.64 ± 0.90	2.67 ± 0.90	2.66 ± 0.90
Baseline ergonomic knowledge score, mean ± SD	53.6 ± 12.0	53.3 ± 11.8	53.5 ± 11.9

3.2 Primary Outcomes

3.2.1 Pain Severity

At baseline, pain severity scores were similar across groups (intervention mean = 2.75; control mean = 2.82). At follow-up, participants in the intervention group demonstrated a reduction in mean pain severity to 2.20 (mean change = −0.56, SD = 0.50), whereas the control group showed negligible improvement (follow-up mean = 2.76; mean change = −0.08, SD = 0.54). Clinically meaningful improvement, defined as a reduction of at least one point, was observed in 55.6% of the intervention group compared with 18.9% of the control group.

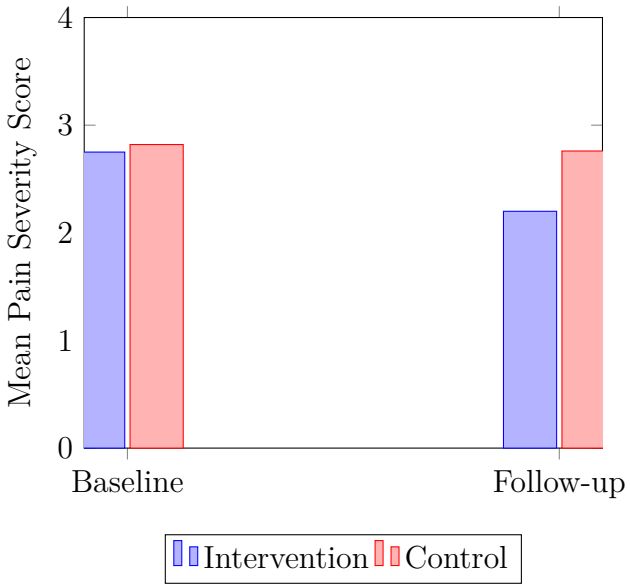

Figure 3.1: Mean pain severity scores at baseline and follow-up by study group

3.2.2 Functional Impairment

Mean baseline functional impairment scores were 2.64 in the intervention group and 2.67 in the control group. At three months, intervention participants improved to a mean score of 2.39 (mean change $= -0.28$, SD $= 0.66$), while control participants remained essentially unchanged (mean change $= -0.05$, SD $= 0.49$). Clinically meaningful improvement was observed in 35.2% of the intervention group and 14.9% of controls.

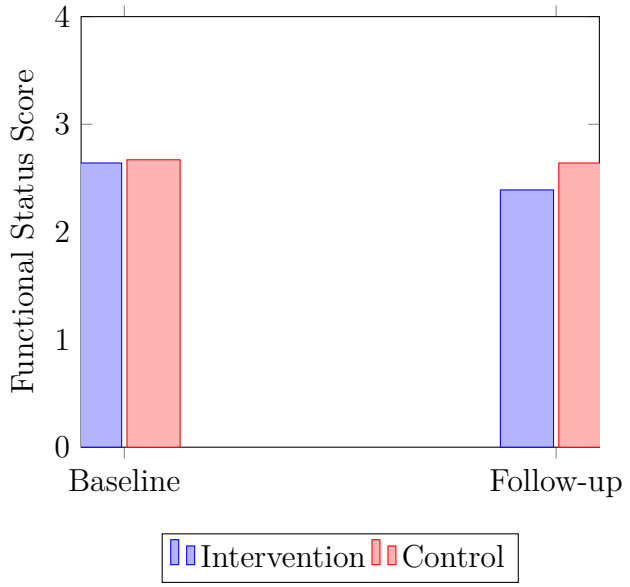

Figure 3.2: Functional status scores before and after the ergonomic education intervention

3.2.3 Ergonomic Knowledge

Knowledge test performance improved substantially among intervention participants, increasing from a baseline mean of 53.6 to 65.4 at follow-up (mean change = +12.0, SD = 6.6). Control participants exhibited only modest improvement, from 53.3 to 56.0 (mean change = +2.5, SD = 5.4). Clinically meaningful gains, defined as an increase of at least 10 points, were observed in 68.5% of the intervention group compared with 9.5% of controls.

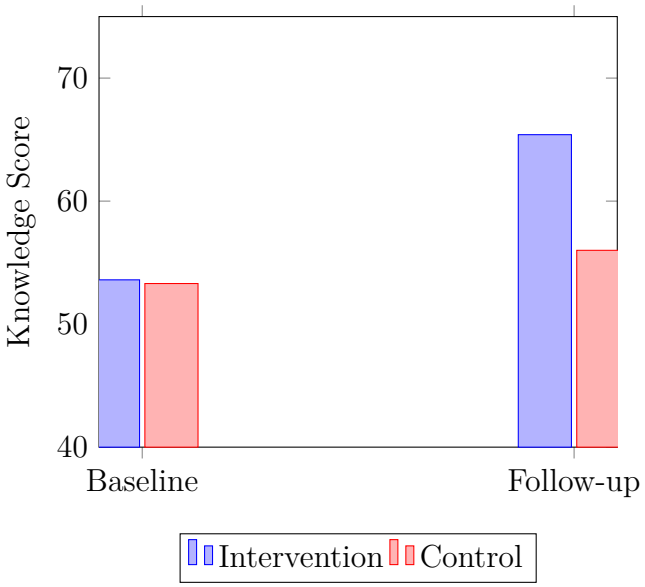

Figure 3.3: Ergonomic knowledge scores at baseline and follow-up by group

3.3 Secondary Outcomes

3.3.1 Clinical Improvement Rates

Overall clinical improvement rates across the three outcome domains are summarized in Figure 3.4. The intervention group consistently demonstrated higher proportions of improvement relative to controls.

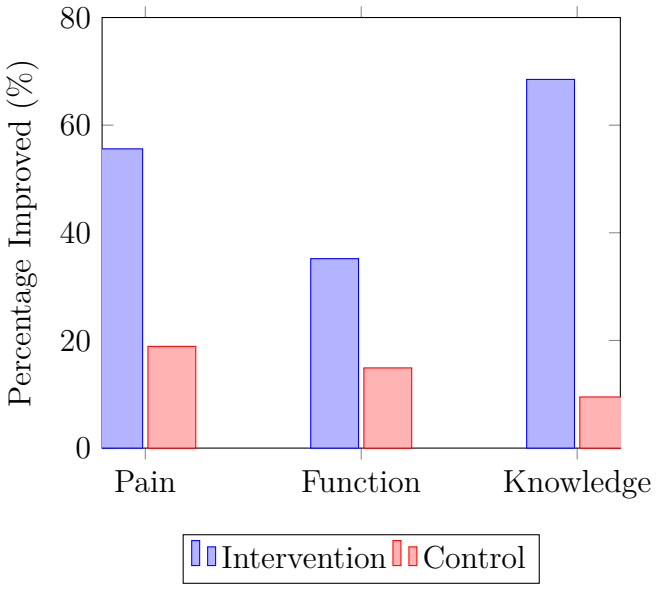

Figure 3.4: Clinical improvement rates across outcome domains

3.3.2 Distribution and Correlation Analyses

Exploratory analyses demonstrated a positive association between daily computer use and baseline pain severity, suggesting that higher exposure was associated with greater symptom burden. Additionally, moderate correlations were observed between daily computer use, continuous usage duration, and pain scores.

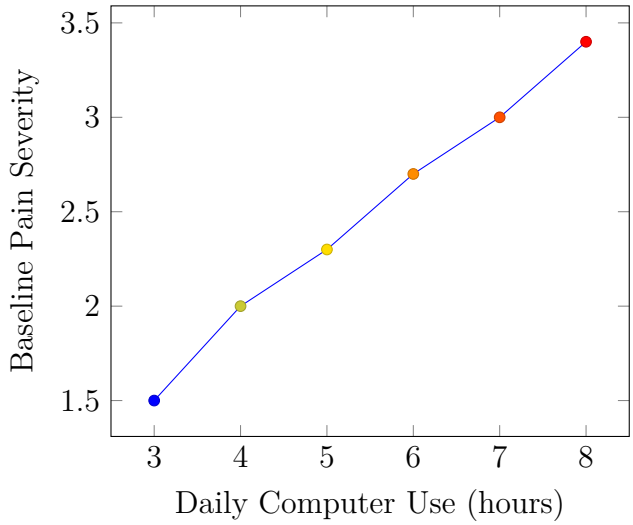

Figure 3.5: Relationship between daily computer use and baseline pain severity

3.4 Summary of Findings

The nursing-led ergonomic education intervention was associated with clinically and statistically meaningful improvements in pain severity, functional impairment, and ergonomic knowledge. Improvements were consistently greater in the intervention group compared

with controls. Exploratory analyses further suggested a dose–response relationship between daily computer use and musculoskeletal symptom burden.

4 Discussion

This study examined the prevalence of wrist soft tissue injury symptoms among undergraduate computer science students at Beni Suef University and evaluated the effectiveness of a nursing-led ergonomic education intervention. The findings demonstrate that wrist-related pain and functional impairment are common in this population and that a structured ergonomic education program delivered by nursing professionals can lead to clinically and statistically meaningful improvements.

4.1 Baseline Prevalence and Risk Factors

At baseline, participants reported moderate levels of wrist pain and functional impairment, consistent with previous studies documenting a high prevalence of upper limb musculoskeletal symptoms among students and professionals with intensive computer use (Sanusi, 2013; Woo et al., 2016). The observed baseline pain severity and functional limitation scores suggest that prolonged exposure to repetitive keyboard and mouse activities represents a substantial occupational health concern even at a young age.

Correlation analyses revealed a positive association between daily computer use duration and pain severity, supporting the biomechanical explanation that cumulative exposure to repetitive movements and sustained non-neutral wrist postures increases mechanical stress on tendons and neural structures (Rempel et al., 1998; Keir et al., 2007). These findings reinforce the role of modifiable ergonomic factors as key contributors to musculoskeletal symptom development.

4.2 Effectiveness of the Nursing-Led Ergonomic Education Intervention

The primary finding of this study is the significant reduction in pain severity observed in the intervention group compared with controls. The magnitude of improvement was both statistically significant and clinically meaningful, with more than half of the intervention participants achieving at least a one-point reduction in pain severity. This level of improvement is consistent with prior intervention studies demonstrating that ergonomic education can reduce musculoskeletal symptoms by promoting behavior change and improved workstation practices (Oakman et al., 2018; Ahmed et al., 2023).

Functional impairment also improved significantly following the intervention, although to a lesser extent than pain severity. This pattern is expected, as functional recovery often lags behind symptom reduction due to the need for sustained behavioral change and tissue

recovery over time. Similar trends have been reported in ergonomic intervention studies where functional improvements were moderate but progressive (Atroshi et al., 2009).

4.3 Impact on Ergonomic Knowledge

Ergonomic knowledge showed the largest effect size among all measured outcomes. This finding highlights the effectiveness of structured educational interventions in increasing awareness and understanding of preventive practices. Knowledge gains are a critical intermediate outcome in health promotion models, as they precede and facilitate sustained behavior change (Pender et al., 2015).

The relatively modest improvement observed in the control group may be attributed to informal learning or increased awareness resulting from study participation, a phenomenon commonly described as the Hawthorne effect. However, the magnitude of improvement in the intervention group far exceeded that of controls, underscoring the added value of targeted nursing-led education.

4.4 Clinical and Educational Implications

From a nursing and occupational health perspective, these findings support the integration of ergonomic education into university health promotion programs. Nursing professionals are uniquely positioned to deliver such interventions due to their expertise in health education, early symptom recognition, and preventive care. Implementing ergonomic training early in academic programs may reduce the long-term burden of musculoskeletal disorders as students transition into technology-intensive professions.

The use of online delivery platforms in this study further demonstrates the feasibility of scalable ergonomic education interventions, particularly in academic settings where in-person sessions may be logistically challenging.

4.5 Study Limitations

Several limitations should be considered when interpreting the results. First, the reliance on self-reported measures may introduce reporting bias. Second, the follow-up period was limited to three months, which may not capture the long-term sustainability of observed improvements. Third, while the quasi-experimental design allowed for practical implementation, randomization was not employed, which may limit causal inference.

4.6 Future Research Directions

Future studies should consider longer follow-up periods to assess the durability of ergonomic education effects and explore the integration of objective ergonomic assessments. Additionally,

randomized controlled trials across multiple universities would strengthen generalizability and causal interpretation.

4.7 Conclusion of Discussion

Overall, this study provides evidence that wrist soft tissue injuries are prevalent among computer science students and that nursing-led ergonomic education is an effective preventive strategy. Addressing ergonomic risk factors early in academic settings may play a critical role in reducing the future burden of work-related musculoskeletal disorders.

5 Conclusion

This study investigated the prevalence, risk factors, and preventive management of wrist soft tissue injuries among undergraduate computer science students at Beni Suef University, with a particular focus on the effectiveness of a nursing-led ergonomic education intervention. The findings demonstrate that wrist pain and functional impairment are common in this population, largely associated with prolonged and continuous computer use.

The ergonomic education intervention resulted in clinically and statistically meaningful improvements in pain severity, functional status, and ergonomic knowledge among participants in the intervention group. Improvements were consistently greater than those observed in the control group, highlighting the value of structured, targeted education delivered by nursing professionals. The substantial gains in ergonomic knowledge further support the role of educational interventions as a foundational component of musculoskeletal injury prevention.

These findings emphasize the importance of early ergonomic awareness and preventive strategies in academic environments, particularly for students in technology-intensive disciplines. Incorporating nursing-led ergonomic education into university health promotion programs may reduce the short- and long-term burden of musculoskeletal disorders and support healthier study and work habits.

Despite certain limitations, including reliance on self-reported measures and a limited follow-up period, this study contributes meaningful evidence to the field of occupational health nursing. Future research should explore long-term outcomes, objective ergonomic assessments, and broader implementation across multiple institutions.

In conclusion, nursing-led ergonomic education represents a feasible, effective, and scalable approach to preventing wrist soft tissue injuries among university students and should be considered an integral component of occupational health initiatives within academic settings.

6 References

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