ORIGINAL ARTICLE

# Prevalence and Ergonomic Risk Profiling of Musculoskeletal Pain in Medical Imaging Students: A Basis for Prevention and Intervention.

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musculoskeletal pain; medical imaging students; ergonomics risk factors; clinical task

**ABSTRACT**

**Background:** Musculoskeletal pain (MSP) is a common problem among university students, particularly those in health-related programmes with significant physical and ergonomic demands during clinical training, and medical imaging students are likely to be similarly affected. The objectives of this study were to identify the risk factors associated with MSP, evaluate its prevalence, frequency, and severity, as well as examine the correlation between MSP frequency and potential risk factors among medical imaging students. **Methods:** A cross-sectional study was conducted using a validated questionnaire. Descriptive statistics and Spearman's correlation were used to analyse the correlation between MSP and potential risk factors. **Results:** The results showed that the most frequently affected body regions were the shoulders (49.2%), lower back (38.1%), and neck (36.5%), with both acute (short-term) and persistent (long-term) pain reported. MSP frequency (past 12 months) showed significant correlations with clinical-task-related variables, particularly repetitive motions (ρ=0.787), extended standing (ρ=0.683), and incorrect postures (ρ=0.744). In contrast, lifestyle factors such as sleep duration and stress management showed weaker associations. **Conclusion:** These findings highlight the need for ergonomic training and preventive strategies to reduce the risk of MSP among medical imaging students. Future studies should examine long-term effects and evaluate intervention strategies to improve clinical performance and student well-being.

## INTRODUCTION

Musculoskeletal pain (MSP) is a common disorder affecting bones, muscles, ligaments, tendons, and nerves, and may present as acute or chronic pain. Acute MSP is localised to a specific body region (e.g. back, neck, shoulder) and is usually related to structures in that area. Chronic MSP refers to pain that persists for more than three months and may be linked to illness or injury, influenced by psychological factors, lack clear biological function, and have no identifiable endpoint.

Pain related to MSP is a frequent medical and socioeconomic problem globally (El-Tallawy et al., 2021). MSP can cause physical discomfort, limit daily activities, and reduce overall quality of life. It can also affect mental health by increasing stress and anxiety and reducing productivity.

The impact of MSP extends beyond individual health and can disrupt healthcare students' engagement in practical training and clinical placements. High MSP prevalence has been reported among dental, healthcare, and allied health students (91.2%, 64.8%, and 73.6%, respectively) (Abdulaziz et al., 2019; Felemban et al., 2021; Senarath et al., 2021; Syafiqah et al., 2021). However, medical imaging students have received comparatively less attention, despite facing similar challenges in their learning and clinical environments.

Medical imaging students are often required to stand for long periods, perform repetitive movements, and maintain awkward postures during imaging procedures. Combined with heavy equipment handling and precise patient positioning, these demands increase their susceptibility to MSP. Extended standing, for example, can lead to foot pain and swelling, varicose veins, fatigue, stiff neck and shoulders, and low back pain (Alias et al., 2020). Yet ergonomic training and interventions for this group are often limited or overlooked, potentially exacerbating these risks.

Although MSP has been widely reported among healthcare and allied health students, evidence on the detailed pattern of MSP (location, severity and frequency) and its ergonomic/lifestyle risk factors specifically in medical imaging students, especially in Malaysia remains limited. Studies involving students in medical imaging or radiography programmes (e.g, Italy, South Africa) have mainly focused on prevalence and a few occupational

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factors, often using study-specific or adapted questionnaires with limited psychometric reporting, despite the availability of validated tools such as the Standardised Nordic Musculoskeletal Questionnaire (Lee & Cho, 2012; Lorusso et al., 2010; Masondo & Khoza, 2023; Syafiqah et al., 2021).

This study adds value by using a validated MSP instrument with 12-month and 7-day recall and a structured risk-factor section to quantify MSP prevalence, frequency, and severity across body regions and examine correlations between the frequency of MSP in the past 12 month with the potential risk factors associated with MSP among medical imaging students. The findings provide evidence to guide early detection and targeted prevention strategies such as ergonomic education, workload modification, and exercise programmes to protect students' musculoskeletal health and reduce future work-related problems.

## MATERIALS AND METHODS

### Study Design and Setting

This cross-sectional study specifically included medical imaging students who had undergone clinical training to ensure better representation of the experiences related to MSP in clinical training. The study was conducted from March 2024 until February 2025 with the approval of the institutional research and ethics committee.

### Population and sampling

The study recruited medical imaging students from Faculty of Allied Health Sciences from a university in Pahang, Malaysia. Applying Slovin's formula at a 5% margin of error (95% confidence interval) to the population of 74 medical imaging students (Years 2-4) produced a minimum sample size of 63, which was then recruited using convenience sampling.

### Questionnaires

Data were collected using a three-part questionnaire: Section 1 covered demographics, Section 2 assessed MSP prevalence and characteristics, and Section 3 examined potential risk factors. Risk-factor items described task-related and postural exposures (e.g. prolonged neck flexion/extension, patient lifting) treated as potential MSP risk factors.

The questionnaire was designed using a five-point Likert-scale which consists of a series of statements response to indicate respondents' pain severity, frequency, and the potential risk factors. These questions were also constructed using an adopt-and-adapt approach based on established and validated MSP instruments, particularly the Standardised Nordic Musculoskeletal Questionnaire by Kuorinka et al. (1987). The prevalence section follows the Nordic convention by assessing symptoms across two recall periods: the past 12 months and the past 7 days.

The 12-month timeframe captures annual prevalence and reflects longer-term or recurrent MSP patterns that may occur intermittently over an academic year. While the 7-day timeframe captures recent prevalence, providing a snapshot of current or very recent symptoms and helping to minimise recall bias. Using both periods enables a clearer distinction between longer-term or recurrent and recent MSP experiences among the students (Kuorinka et al., 1987; Dawson et al., 2009; Legault et al., 2014; Rasmussen et al., 2018; Umar et al., 2025).

The Likert-scale questionnaire was reviewed by five experts (medical imaging academicians and practising radiographers). The validation ensured that items were relevant, clear, and appropriate for medica lmaging students, and minimised leading or biased wording. Based on their feedback on redundancy, ambiguity, and consistency, the questionnaire was refined before distribution.

Cronbach's alpha was used to assess internal consistency. Alpha coefficients were 0.743 for MSP experience, 0.891 for severity, 0.909 for frequency, and 0.799 for potential risk factors, all above the 0.70 threshold (Bonett & Wright, 2015). This indicates acceptable to excellent reliability, suggesting the questionnaire is suitable for assessing MSP prevalence, characteristics, and related risk factors among medical imaging students.

### Data Collection

All respondents received a brief study information sheet explaining the study purpose, and confidentiality of their responses before given the questionnaire. Participation was entirely voluntary; informed consent was obtained prior to data collection, and they could withdraw at any point without any penalty or loss of benefits. The online questionnaire (via Google Forms) was open for one month, with reminders sent three times per week to medical imaging students, and this period was deemed sufficient for data collection.

### Analysis

All completed responses were analysed using the Statistical Package for the Social Sciences (SPSS) version 20. Demographic characteristics, MSP prevalence and severity, and potential risk factors were summarised using

descriptive statistics (frequencies, percentages, means, and standard deviations).

The study also investigated whether there was any correlation between the frequency of MSP in the past 12 months and the identified potential risk factors. The 12-month measure was used because it reflects longer-term or recurrent symptoms and is more consistent with habitual ergonomic and lifestyle exposures. The 7-day measure was reported descriptively only, as it represents short-term, potentially transient symptoms.

Before correlation analysis, data normality was assessed using the Kolmogorov–Smirnov test ($p > 0.05$ indicating normal distribution). Correlations were considered statistically significant at $p \leq 0.05$, and their strength was interpreted from the correlation coefficient (r), with values closer to 0 indicating negligible association and larger absolute values (approximately 0.1–0.3 small, 0.3–0.5 moderate, >0.5 strong) indicating progressively stronger associations (Laerd Statistics, 2018).

## RESULTS

### Demographic Characteristics of Respondents

A total of 63 students pursuing degrees in medical imaging participated in the study (16 males, 47 females) from Years 2–4 (Year 2: 18, Year 3: 25, Year 4: 20). Over half had a BMI in the normal range (n = 37, 58.7%), with the remainder distributed across underweight (n = 11), overweight (n = 9), and obese or extremely obese categories (n = 6). Only four students (6.3%) reported a previous history of MSP. Fewer than one-quarter (n = 15, 23.8%) reported using ergonomic equipment, and none reported smoking or vaping.

### Site-specific Prevalence of MSP

This section reports the site-specific prevalence of MSP shown as number(n) and percentage (%) of students who reported MSP in each body region at least once during the specified period. Students were permitted to choose various sites, resulting in percentages that do not sum to 100%.

For the duration of past 12 months (Table 1), the most frequently cited sites were the shoulders (n = 31, 49.2%), lower back (n = 24, 38.1%), neck (n = 23, 36.5%), and ankles/feet (n = 20, 31.7%). Moderate numbers of students also reported pain in the upper back and hips/thighs (each n = 17, 27.0%), followed by the knee (n = 14, 22.2%) and wrist/hands (n = 13, 20.6%), while the elbow was least reported (n = 6, 9.5%).

Meanwhile for the duration of past 7 days (Table 1), lower back pain was the most frequently reported (n = 16, 25.4%), followed by pain in the neck (n = 10, 15.9%) and knees (n = 9, 14.3%). Shoulder and wrist/hand pain were each reported by eight students (12.7%), whereas pain in the upper back, hips/thighs and ankles/feet was less common (each n = 3, 4.8%). No students reported elbow pain in the preceding week.

**Table 1:** Experience of MSP in Specific Body Locations among Medical Imaging Students in the Past 12 Months and the Past 7 Days

| MSP in any of the following body region | In the past 12 months n (%) | In the past 7 days n (%) |
|---|---|---|
| Neck | 23 (36.5) | 10 (15.9) |
| Shoulders | 31 (49.2) | 8 (12.7) |
| Elbow | 6 (9.5) | 0 (0) |
| Wrist/Hands | 13 (20.6) | 8 (12.7) |
| Upper back | 17 (27.0) | 5 (7.9) |
| Lower back | 24 (38.1) | 16 (25.4) |
| Hips/Thighs | 17 (27.0) | 3 (4.8) |
| Knee | 14 (22.2) | 9 (14.3) |
| Ankles/Feet | 20 (31.7) | 3 (4.8) |

*'n': number of respondents; %: percentage of respondents; MSP: Musculoskeletal pain*

### Frequency of MSP by Body Region

Table 2 summarises MSP frequency by body region among medical imaging students reporting pain in the past 12 months. The lower back, shoulders, and neck were the most commonly affected regions, whereas elbows and wrists/hands were least reported. For most body regions, MSP was most frequently rated at level 2 on the frequency scale, indicating relatively infrequent episodes, while lower back symptoms were most often rated at level 3 (50.0%, n = 12), suggesting more recurrent pain in this area. Overall, these findings highlight the lower back, shoulders, and neck as priority regions for prevention, likely related to postural and patient-handling demands during clinical training.

**Table 2:** Frequency of MSP in the Past 12 Months

| Body region | n with MSP | Most common frequency response category *, n (%) |
|---|---|---|
| Neck | 23 | 2 (Rarely), 11 (47.8) |
| Shoulders | 31 | 2(Rarely), 14 (45.2) |
| Elbow | 6 | 2(Rarely),4 (66.7) |
| Wrist/Hands | 13 | 2(Rarely), 6 (46.2) |
| Upper back | 17 | 2–3 (Rarely-Sometimes), 6 each (35.3) |
| Lower back | 24 | 3 (Sometimes), 12 (50.0) |

| Body region | n with MSP | Most common frequency response category *, n (%) |
|---|---|---|
| Hips/Thighs | 17 | 2(Rarely), 8 (47.1) |
| Knee | 14 | 2(Rarely), 9 (64.3) |
| Ankles/Feet | 20 | 2(Rarely), 10 (50.0) |

*'n': number of respondents; %: percentage of respondents; MSP: Musculoskeletal pain; Responses were originally collected on a 5-point Likert scale and recoded into "1-never", "2-rarely", "3-sometimes", "4-often", and "5-always"; Only the most common response category for each body region is shown*

Table 3 shows the distribution of MSP in the past 7 days by body region. The lower back had the highest number of students reporting recent pain (n = 16), followed by the neck and knees. When focusing on frequent symptoms (rated often/always), the upper back (60.0%), hips/thighs (66.7%), and lower back (37.5%) showed the greatest proportions, indicating more persistent recent pain in these areas. In contrast, elbow pain was not reported in the past 7 days duration, and neck, knee, and ankle/foot pain were generally less frequent. Overall, recent MSP remained most prominent in the back regions and lower limbs, consistent with the postural and handling demands of clinical training.

**Table 3:** Frequency of MSP in the Past 7 Days

| Body region | n with MSP | Most common frequency response category*, n (%) |
|---|---|---|
| Neck | 10 | 2 (Rarely), 3 (30.0) |
| Shoulders | 8 | 3 (Sometimes),4 (50.0) |
| Elbow | 0 | - |
| Wrist/Hands | 8 | 3-4(Sometimes-Often), 3 each (37.5) |
| Upper back | 5 | 4 (Often), 3 (60.0) |
| Lower back | 16 | 4(Often), 6 (37.5) |
| Hips/Thighs | 3 | 4(Often), 2 (66.7) |
| Knee | 9 | 2 (Rarely), 6 (66.7) |
| Ankles/Feet | 3 | 2 (Rarely), 2 (66.7) |

*'n': number of respondents; %: percentage of respondents; MSP: Musculoskeletal pain; Responses were originally collected on a 5-point Likert scale and recoded into "1-never", "2-rarely", "3-sometimes", "4-often", and "5-always"; Only the most common response category for each body region is shown; – No MSP reported in this body region*

**Severity of MSP by Body Region**

This section reports the severity of MSP, which indicates how intense the pain was in each body region during the specified time frames.

Table 4 describes the most common severity levels of MSP in the past 12 months for each body region among students who reported pain. Overall, symptoms were predominantly mild (category 2) in most regions, including the neck (69.6%), wrists/hands (69.2%), upper back (52.9%), lower back (50.0%), knees (35.7%), and ankles/feet (50.0%). Shoulder pain stood out as generally moderate (category 3), reported by more than half of those with shoulder MSP (54.8%). For hips/thighs, mild and moderate pain were equally common (29.4% each), while elbow symptoms were infrequent and most often rated as no pain (category 1) over the 12-month period. These patterns indicate that, although MSP is widespread across multiple body regions, it is usually of mild to moderate severity rather than severe or very severe.

**Table 4:** Severity of MSP in the Past 12 Months

| Body region | n with MSP | Most common severity response category*, n (%) |
|---|---|---|
| Neck | 23 | 2 (Mild), 16 (69.6) |
| Shoulders | 31 | 3 (Moderate), 17 (54.8) |
| Elbow | 6 | 1 (No Pain), 3 (50.0) |
| Wrist/Hands | 13 | 2(Mild), 9 (69.2) |
| Upper back | 17 | 2(Mild), 9 (52.9) |
| Lower back | 24 | 2(Mild), 12 (50.0) |
| Hips/Thighs | 17 | 2-3(Mild-Moderate), 5 each (29.4) |
| Knee | 14 | 2(Mild), 5 (35.7) |
| Ankles/Feet | 20 | 2(Mild), 10 (50.0) |

*'n': number of respondents; %: percentage of respondents; MSP: Musculoskeletal pain; Responses were originally collected on a 5-point Likert scale and recoded into "1-no pain", "2-, mild pain", "3-moderate pain", "4-severe pain", and "5-very severe pain"; Only the most common response category for each body region is shown*

Table 5 presents the most common severity levels of MSP in the past 7 days among students who reported recent pain. For several regions, recent symptoms were mainly mild (category 2), including the neck (40.0%), shoulders (37.5%), knees (66.7%), and ankles/feet (66.7%). In contrast, moderate pain (category 3) was most common in the wrists/hands (50.0%), while the upper back showed predominantly severe pain (category 4; 60.0%). Lower back symptoms were split evenly between moderate and severe pain (37.5% each), suggesting more intense recent discomfort in this region. Hips/thighs showed a mixed pattern with one case each of no, severe, and very severe pain. Overall, these findings indicate that, although many students experienced only mild MSP in the previous week, the upper and lower back and wrists/hands were notable sites of more severe recent pain.

**Table 5:** Severity of MSP in the Past 7 Days

| Body region | n with MSP | Most common severity response category, n (%) |
|---|---|---|
| Neck | 10 | 2(Mild), 4 (40.0) |
| Shoulders | 8 | 2(Mild), 3 (37.5) |
| Elbow | 0 | - |
| Wrist/Hands | 8 | 3(Moderate), 4 (50.0) |
| Upper back | 5 | 4 (Severe), 3 (60.0) |
| Lower back | 16 | 3-4(Moderate-Severe), 6 each (37.5) |
| Hips/Thighs | 3 | 1,4,5 (No pain, Severe, Very Severe), 1 each (33.3) |
| Knee | 9 | 2(Mild), 6 (66.7) |
| Ankles/Feet | 3 | 2(Mild), 2 (66.7) |

*'n': number of respondents; %: percentage of respondents; MSP: Musculoskeletal pain; Responses were originally collected on a 5-point Likert scale and recoded into "1-no pain", "2-, mild pain", "3-moderate pain", "4-severe pain", and "5-very severe pain"; Only the most common response category for each body region is shown; – No MSP reported in this body region*

## Correlation Study

This section addresses the specific research objective to correlate the frequency of MSP in the past 12 months with the potential risk factors associated with MSP in medical imaging students.

*Potential Risk Factor Associated With MSP*

Table 6 shows that most potential MSP-related risk factors were reported as infrequent, with only a subset of students experiencing them often. The most frequently reported exposure was lower back discomfort during bending, twisting, or lifting patients (31.7%), followed by neck and shoulder discomfort, upper and ankle/foot discomfort, taking short breaks, and practising stress-management techniques (around 20–25%). Overall, these results indicate that postural and handling strains are present during clinical training, but only a minority of students experience them frequently or on a regular basis.

**Table 6:** Frequency of potential MSP-related risk factors among Medical Imaging students

| No. | Risk factor item (summary) | Frequent n (%) | Mean (SD) |
|---|---|---|---|
| 1 | Neck discomfort when looking up/down for prolonged periods | 15 (23.8) | 2.73 (1.10) |
| 2 | Shoulder discomfort during repetitive tasks | 15 (23.8) | 2.57 (1.16) |
| 3 | Elbow discomfort when lifting/supporting patients | 0 (0.0) | 1.60 (0.75) |
| 4 | Wrist/hand discomfort with forceful or repetitive hand movements | 7 (11.1) | 2.29 (1.13) |
| 5 | Upper back discomfort after maintaining bent-over posture | 14 (22.2) | 2.37 (1.20) |
| 6 | Lower back discomfort when bending, twisting, or lifting patients | 20 (31.7) | 2.98 (1.09) |
| 7 | Hip/thigh discomfort after prolonged standing | 4 (6.4) | 2.02 (1.06) |
| 8 | Knee discomfort when bending or squatting | 7 (11.1) | 2.17 (1.17) |
| 9 | Ankle/foot discomfort after walking or standing for long hours | 14 (22.2) | 2.38 (1.21) |
| 10 | Taking short breaks during extended periods of work | 16 (25.4) | 2.97 (0.98) |
| 11 | Engaging in physical activity/exercise | 14 (22.2) | 2.81 (1.00) |
| 12 | Getting enough sleep (≥7 hours/night) | 12 (19.0) | 2.70 (1.13) |
| 13 | Practising stress-management techniques | 15 (23.8) | 2.75 (1.15) |

*Responses were originally collected on a 5-point Likert scale and recoded into "not frequent," "sometimes," and "frequent"; only the "frequent" category is presented here for conciseness*

*Correlation Analysis*

The Kolmogorov–Smirnov test showed that MSP frequency in the past 12 months (Table 2) and all potential risk factors were non-normally distributed (all $p < 0.05$). Consequently, Spearman's correlation was used to examine the relationships between MSP frequency and these risk factors.

Table 7 shows that most significant associations were positive and strong between MSP frequency and discomfort-related ergonomic factors in the corresponding body regions. Strong correlations were observed for neck pain with looking up/down for prolonged periods ($\rho = 0.712$), shoulder pain with repetitive tasks such as equipment handling and patient positioning ($\rho = 0.787$), upper back pain with maintaining a bent-over posture ($\rho = 0.727$), lower back pain with bending, twisting, or lifting patients ($\rho = 0.744$), knee pain with bending or squatting ($\rho = 0.713$), and hips/thigh and ankles/feet pain with prolonged standing or walking during clinical training ($\rho = 0.673$ and $\rho = 0.683$, respectively). Wrist/hand pain also showed a strong correlation with forceful or repetitive hand movements ($\rho = 0.654$), while hips/thigh pain demonstrated a weak but

significant correlation with short breaks during extended work periods (ρ = 0.255). Overall, these findings indicate that more frequent MSP in each body region is closely linked to higher levels of corresponding postural and patient-handling discomfort, underscoring the role of ergonomic demands during clinical training in the development of MSP among medical imaging students.

**Table 7:** Significant correlations between MSP frequency (past 12 months) and potential risk factors (Spearman's ρ)

| Body region | Risk factor item (summary) | Spearman's ρ | Strength* | p-value |
|---|---|---|---|---|
| Neck | Discomfort due to looking up or down for prolonged periods | 0.712 | Strong | 0.000 |
| Shoulders | Discomfort due to repetitive tasks (e.g., equipment handling, patient positioning) | 0.787 | Strong | 0.000 |
| Elbows | Discomfort when lifting or supporting patients during clinical training | 0.503 | Moderate | 0.000 |
| Wrists/ Hands | Discomfort due to forceful gripping, twisting, or repetitive hand movements | 0.654 | Strong | 0.000 |
| Upper back | Discomfort due to maintaining a bent-over posture during clinical tasks | 0.727 | Strong | 0.000 |
| Lower back | Discomfort due to bending, twisting, or lifting patients | 0.744 | Strong | 0.000 |
| Hips/ Thighs | Discomfort due to prolonged standing during clinical training | 0.673 | Strong | 0.000 |
| Hips/ Thighs | Short break during extended period of work | 0.255 | Weak | 0.044 |
| Knees | Discomfort due to bending or squatting | 0.713 | Strong | 0.000 |
| Ankles/ Feet | Discomfort due to walking or standing for long hours during clinical training | 0.683 | Strong | 0.000 |

*Note: weak 0.20–0.39, moderate 0.40–0.59, strong ≥0.60. Only statistically significant correlations (p ≤ 0.05) are reported; full correlation outputs are available from the corresponding author on reasonable request*

## DISCUSSION

The study shows that MSP is a prominent problem among medical imaging students, despite most respondents being non-smokers, having a normal BMI, and reporting no previous MSP diagnosis. The participants was predominantly female and drawn from multiple years of study, reflecting varying degrees of clinical exposure. Although only a small proportion reported using ergonomic equipment, MSP was common across several body regions, suggesting that current preventive practices may be insufficient for this group.

Across the body regions examined, the lower back, shoulders, neck, and upper back emerged as the main areas of concern. Using the 12-month recall capturing longer-term or recurrent symptoms, lower back pain showed the highest frequency ratings, with a substantial proportion of students reporting symptoms at intermediate levels on the frequency scale (e.g. "sometimes" or "often"), while shoulders and neck followed closely. In contrast, elbow and wrist/hand symptoms were relatively infrequent and generally rated at lower frequency levels, indicating that these joints may be under comparatively less strain in typical imaging activities.

For the past 7 days duration, lower back pain again featured most prominently, with smaller numbers reporting recent symptoms in the neck, knees, and upper back, highlighting that MSP is not only a historical problem but also a current issue for many students. These findings are broadly consistent with previous work among medical imaging students in other settings, where the lower back, neck, and upper back are also commonly affected. For example, Lorusso et al., (2010) reported that low back pain was the most frequent complaint among Italian medical imaging students, with neck and shoulder symptoms also prevalent. Similarly, a study of undergraduate radiography students in South Africa found a very high prevalence of musculoskeletal disorders (92.4%), with the lower back (79.7%), neck (72.2%), and upper back (54.1%) most frequently affected (Masondo & Khoza, 2023).

In terms of severity, MSP over the past 12 months was predominantly mild across most body regions, particularly in the neck, wrists/hands, upper back, lower back, knees, and ankles/feet, while shoulder symptoms were more often rated as moderate. This pattern suggests that, although MSP is widespread, it is usually not severe over the longer term. However, the 7-day data indicate that recent symptoms can be more intense in specific regions: upper back pain was most commonly severe, and lower back pain was split between moderate and severe levels,

whereas neck, knee, and ankle/foot pain in the past week was mainly mild.

Taken together, the severity and frequency findings indicate a mainly mild-to-moderate, yet recurrent, MSP burden that is strongly concentrated in the spine, especially the lower back, with notable episodes of more severe pain in both the upper and lower back. This recurring pattern suggests that spinal and shoulder regions are consistently vulnerable during radiography training and early clinical exposure. Consequently, these areas should be prioritised in ergonomic prevention strategies, including posture training, safer patient-handling techniques, and adjustments to clinical work routines.

The analysis of potential risk factors in this study highlights task-related and postural exposures as key contributors to MSP. Strong positive correlations were observed between neck pain and activities involving prolonged neck flexion/extension, shoulder pain and repetitive shoulder tasks, upper and lower back pain and bending, twisting, or lifting patients, and lower-limb pain and prolonged standing or walking during clinical work. These moderate to strong correlations supports previous evidence that physical workload and awkward postures are central drivers of MSP among radiography students and practitioners.

Additional correlation analyses (not shown in tables) indicated that lifestyle-related factors such as physical activity, sleep duration, and stress-management practices did not show significant correlations with MSP frequency in this cohort, suggesting that clinical task demands and work posture may exert a stronger influence on MSP than general lifestyle habits during training.

The data for potential risk factors also provide useful context. While most students reported many exposures as infrequent, a substantial subgroup experienced certain high-risk tasks regularly, particularly lower back discomfort during bending, twisting, or lifting patients, and discomfort related to prolonged standing or walking. This aligns with broader literature on healthcare and allied health students, which consistently links manual handling, static standing, and constrained postures to MSP and work-related musculoskeletal disorders.

## CONCLUSION

The findings of this study have several practical implications. First, they underscore the importance of integrating structured ergonomics education into medical imaging curricula, with explicit emphasis on safe patient handling, posture optimisation, and micro-break strategies during imaging procedures. Second, clinical training sites should consider workload management and simple environmental adjustments (e.g. equipment positioning, use of aids for patient transfer) to reduce static loading and awkward postures. Third, early identification and support for students reporting frequent or severe MSP, particularly in the lower back and upper back, may help prevent progression to chronic symptoms as they enter the workforce.

This study has some limitations that must be acknowledged. Data were collected over a relatively short period and from a single institution, resulting in a modest sample size that may limit the precision and generalisability of estimates. The cross-sectional, self-report design is also susceptible to recall bias and individual differences in pain perception, and causal relationships between MSP and the identified risk factors cannot be inferred. Nevertheless, the use of a validated MSP instrument with 12-month and 7-day recall, alongside a structured set of task-related and postural exposure items, strengthens the internal validity of the findings and provides a more detailed picture of MSP patterns than many previous studies.

Future research should build on these results by employing longitudinal designs to track MSP trails across academic years and clinical rotations, and by evaluating the impact of targeted ergonomic and workload interventions over time. Experimental or quasi-experimental studies testing posture and handling training, ergonomic modifications, and structured physical-activity programmes would help determine which strategies are most effective in reducing MSP among medical imaging students. Larger, multi-institution cohorts would further enhance generalisability and allow comparison across different training environments and clinical settings.

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## REFERENCES

Abdulaziz, A. A., Althaqafi, A. M., Hindi, A. M., Khan, S. A., Atalla, A. A., & Hendi, O. M. (2019). Prevalence of musculoskeletal disorders and its correlation to physical activity among health specialty students. *International Journal of Preventive Medicine*, *10*(1), 19–24. https://doi.org/10.4103/IJPVM.IJPVM_436_18

Alias, A. N., Karuppiah, K., How, V., & Perumal, V. (2020). Does Prolonged Standing at Work Among Teachers Associated with Musculoskeletal Disorders (MSDs)? In *Malaysian Journal of Medicine and Health Sciences* (Vol. 16, Issue 2).

Bonett, D. G., & Wright, T. A. (2015). Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning. *Journal of Organizational Behavior*, *36*(1), 3–15. https://doi.org/10.1002/JOB.1960

Dawson, A. P., Steele, E. J., Hodges, P. W., & Stewart, S. (2009). Development and Test-Retest Reliability of an Extended Version of the Nordic Musculoskeletal Questionnaire (NMQ-E): A Screening Instrument for Musculoskeletal Pain. *Journal of Pain*, *10*(5), 517–526. https://doi.org/10.1016/j.jpain.2008.11.008

El-Tallawy, S. N., Nalamasu, R., Salem, G. I., LeQuang, J. A. K., Pergolizzi, J. V., & Christo, P. J. (2021). Management of Musculoskeletal Pain: An Update with Emphasis on Chronic Musculoskeletal Pain. *Pain and Therapy*, *10*(1), 181–209. https://doi.org/10.1007/S40122-021-00235-2/METRICS

Felemban, R. A., Sofi, R. A., Alhebshi, S. A., Alharbi, S. G., Farsi, N. J., Abduljabbar, F. H., & Farsi, J. M. A. (2021). Prevalence and predictors of musculoskeletal pain among undergraduate students at a dental school in Saudi Arabia. *Clinical, Cosmetic and Investigational Dentistry*, *13*, 39–46. https://doi.org/10.2147/CCIDE.S292970

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G., & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, *18*(3), 233–237. https://doi.org/10.1016/0003-6870(87)90010-X

Laerd Statistics. (2018). *Pearson's product-moment correlation using SPSS Statistics.* Statistical Tutorials and Software Guides. Retrieved from https://statistics.laerd.com/

Lee, J., & Cho, J.-H. (2012). Survey of the musculoskeletal disorders of radiological technologists. *Journal of the Korean Society of Radiology*, *6*(1), 53–61. https://doi.org/10.7742/JKSR.2012.6.1.053

Legault, É. P., Cantin, V., & Descarreaux, M. (2014). Assessment of musculoskeletal symptoms and their impacts in the adolescent population: Adaptation and validation of a questionnaire. *BMC Pediatrics*, *14*(1). https://doi.org/10.1186/1471-2431-14-173

Lorusso, A., Vimercati, L., & L'Abbate, N. (2010). Musculoskeletal complaints among Italian x-ray technology students: A cross-sectional questionnaire survey. *BMC Research Notes*, *3*(1), 114-. https://doi.org/10.1186/1756-0500-3-114/TABLES/3

Masondo, S. S., & Khoza, T. E. (2023). Musculoskeletal disorders among undergraduate radiography students during work integrated learning in Kwazulu-Natal, South Africa. *Journal of Medical Imaging and Radiation Sciences*, *54*(1), 153–161. https://doi.org/10.1016/J.JMIR.2022.12.008

Rasmussen, C. D. N., Holtermann, A., & Jørgensen, M. B. (2018). Recall Bias in Low Back Pain among Workers. *Spine*, *43*(12), E727–E733. https://doi.org/10.1097/BRS.0000000000002457

Senarath, M., Thalwaththe, S., & Tennakoon, S. (2021). Prevalence of Selected Musculoskeletal Disorders among the Students of Faculty of Allied Health Sciences, University of Peradeniya. *Journal of Musculoskeletal Disorders and Treatment*, *7*(2), 097. https://doi.org/10.23937/2572-3243.1510097

Syafiqah, N., Kamalruzaman, A., Adilah, T., Sabri, T., Nor, S., & Isa, I. (2021). Musculoskeletal disorders and quality of life among undergraduate health sciences students: A cross-sectional study. *Healthscope: The Official Research Book of Faculty of Health Sciences, UiTM*, *4*(1), 99–105. https://healthscopefsk.com/index.php/research/article/view/231

Umar, L., Abdullahi, U., Kaka, B., & Aliyu, F. H. (2025). Prevalence and multifactorial determinants of musculoskeletal pain among family caregivers of stroke survivors in Northwestern Nigeria: a cross-sectional analysis with implications for policy and practice. *Discover Public Health*, *22*(1). https://doi.org/10.1186/s12982-025-01025-3