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Prevalence of Musculoskeletal Disorders and Ergonomic Practices Among Pediatric Dentists in Jordan: A Cross-Sectional Study

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Abstract

Work-related musculoskeletal disorders (WMSDs) represent a severe occupational hazard in dentistry, with pediatric dentists facing unique biomechanical challenges due to the demanding nature of patient behavior management. Despite the recognized global burden, there is a critical scarcity of targeted ergonomic research regarding this high-risk specialty in developing nations. This descriptive, cross-sectional study aimed to evaluate the prevalence, anatomical distribution, and severity of WMSDs among pediatric dentists in Jordan, and to investigate the direct associations between these disorders and specific ergonomic practices. A validated survey, adapted from the Standardized Nordic Questionnaire, was administered to 110 licensed pediatric dentists. The clinical data revealed an alarmingly high WMSD prevalence, with 88.2% of practitioners reporting musculoskeletal pain in the past 12 months, predominantly affecting the neck (62.7%), shoulders (58.2%), and lower back (52.7%). Female pediatric dentists exhibited a significantly higher susceptibility to both cervical ($p=0.008$) and lumbar pain ($p<0.001$). Crucially, the non-utilization of magnification loupes was significantly associated with increased neck pain ($p=0.020$), while the absence of four-handed dentistry proved to be a primary catalyst for severe lower back pain ($p<0.001$). Furthermore, the high pain severity led to significant occupational disruption, with 49.1% of dentists requiring sick leave, exacerbated by a widespread neglect of preventive micro-breaks and stretching. Based on the synthesis of these findings, WMSDs are a highly prevalent and debilitating risk for pediatric dentists. Strict adherence to fundamental ergonomic interventions—specifically the use of magnification loupes and four-handed dentistry—is mechanically crucial for occupational longevity. The severity of the problem firmly establishes the urgent need to transition from passive awareness to the active, mandatory implementation of ergonomic protocols and gender-sensitive preventive strategies in pediatric dental practice.

Keywords: musculoskeletal disorders; pediatric dentistry; ergonomic practices; occupational health; work-related pain; Jordan

1. Introduction

Dentistry is globally recognized as one of the most physically demanding professions, characterized by a high prevalence of occupational hazards that significantly impact the health and professional longevity of practitioners [1, 6, 8]. Among these hazards, work-related musculoskeletal disorders (WMSDs) represent a major concern, encompassing a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, nerves, and joints [3, 5, 9]. These disorders often manifest early in a dentist's career and are directly linked to the unique nature of clinical practice, which requires prolonged static postures, repetitive movements, and maintaining awkward positions to achieve adequate access and visibility within the limited oral cavity [5, 8]. Specifically, pediatric dentistry presents a more complex ergonomic challenge; the necessity of managing uncooperative child patients often forces clinicians into extreme trunk inclinations and neck flexions,

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further exacerbating the mechanical load on the spinal column and upper extremities [2, 7]. Recent evidence indicates that if left unaddressed, these chronic physical strains lead to decreased productivity, diminished quality of life, and in severe cases, premature retirement from clinical practice [4, 5, 8].

Extensive literature has quantified the burden of these disorders, revealing alarmingly high prevalence rates across the dental workforce. Systematic reviews indicate that the prevalence of neck pain among dental practitioners ranges widely from 13.0% to 84.6%, while low back pain is reported to affect between 15.7% and 88.9% of the population [10, 11, 17]. This occupational burden is pervasive; recent findings by Aljanakh (2024) reported an 85.7% annual prevalence of MSDs among dental assistants, with the shoulders and lower back being the most frequently affected anatomical sites [13, 15]. Crucially, comparative studies highlight that pediatric dentists face distinct risks; evidence suggests they suffer from higher frequencies of back pain compared to general dentists, a disparity attributed to the unbalanced postures required during pediatric behavior management and sedative treatments [14]. Furthermore, demographic variables play a significant role in susceptibility. Recent data from Indonesia and Jordan indicate a significant gender disparity, with female practitioners demonstrating a higher propensity for developing MSDs compared to their male counterparts [12, 19]. Additionally, the onset of these symptoms appears to be shifting earlier, with high prevalence rates observed even among dental students before graduation [16], alongside persistent specific challenges such as hand disorders reported in developed healthcare systems like Germany [18].

Despite the extensive global literature highlighting the burden of musculoskeletal disorders among dental professionals, there remains a noticeable scarcity of focused research addressing the specific ergonomic challenges faced by pediatric dentists in developing nations, particularly in Jordan. Most existing studies either group all dental specialties together or focus predominantly on general practitioners in Western populations, leaving a significant gap in the literature regarding this specific high-risk specialty. Therefore, this study aims to evaluate the prevalence, anatomical distribution, and severity of work-related musculoskeletal pain among pediatric dentists. Furthermore, it seeks to investigate the direct association between the incidence of these disorders and current ergonomic practices, such as the use of magnification loupes and four-handed dentistry. By addressing this gap, the findings will provide crucial, context-specific data to help formulate targeted occupational health protocols and preventive strategies.

2. Materials and Methods

2.1. Study Design and Setting

Study Design and Setting A descriptive, cross-sectional online survey was conducted targeting pediatric dentists actively practicing in Jordan. The study was carried out to evaluate the prevalence of work-related musculoskeletal disorders (WMSDs) and to observe the current ergonomic practices within this specific dental specialty.

2.2. Participants and Sample Size

The target population included licensed pediatric dentists working in various sectors, including private clinics and governmental hospitals. Utilizing a convenience sampling technique, the study aimed to achieve adequate statistical power, successfully yielding a final sample of 110 eligible respondents. Dentists who were retired, not currently practicing, or those with a history of severe musculoskeletal trauma unrelated to dental practice were excluded from the study. An electronic link to the survey was distributed through professional dental networks and social media platforms (e.g., WhatsApp groups, LinkedIn, and Facebook dental communities) over a defined data collection period.

2.3. Data Collection Instrument

Data were collected using a structured, self-administered questionnaire via Google Forms. The questionnaire was developed in English and adapted from the Standardized Nordic Questionnaire

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for the analysis of musculoskeletal symptoms [X], tailored specifically to the dental context. The survey required approximately two minutes to complete and was divided into three main sections:

1. **Socio-demographic and Occupational Characteristics:** This included gender, age, years of clinical experience, and the sector of practice.
2. **Ergonomic Practices and Work Habits:** This section evaluated daily working hours, patient volume, utilization of magnification loupes, adherence to four-handed dentistry, and the practice of regular physical stretching or exercise.
3. **Prevalence and Severity of MSDs:** Participants were asked to report the occurrence of work-related musculoskeletal pain over the past 12 months, specifying the anatomical locations (e.g., neck, lower back, shoulders, wrists), rating the severity on a scale of 1 to 10, and indicating whether the pain had ever necessitated taking a sick leave.

2.4. Ethical Considerations

As this study involved an anonymous, non-interventional online survey with no collection of identifiable personal data (such as names, emails, or IP addresses), a formal Institutional Review Board (IRB) approval was waived. However, the study was conducted in full accordance with the ethical principles of the Declaration of Helsinki. A mandatory digital informed consent statement was placed on the first page of the questionnaire, clearly explaining the study's purpose, the voluntary nature of participation, and assuring absolute data confidentiality. Proceeding to answer the survey questions constituted explicit consent to participate.

2.5. Statistical Analysis

Upon completion of the data collection phase, responses were exported to a Microsoft Excel spreadsheet, cleaned, and coded. The statistical analysis was subsequently performed using IBM SPSS Statistics version 31.0. Prior to inferential analysis, the internal consistency of the questionnaire was verified using Cronbach's Alpha coefficient. Descriptive statistics, including frequencies and percentages, were calculated to summarize the demographic data and the prevalence of MSDs across different anatomical sites. The Pearson Chi-square test ($\boldsymbol{X^2}$) was employed to assess the statistical significance of associations between categorical variables, such as the relationship between ergonomic practices (e.g., using loupes) and the incidence of specific regional pain. A p-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Reliability of the Questionnaire

Prior to conducting the main descriptive and inferential analyses, the internal consistency and reliability of the utilized questionnaire were evaluated using IBM SPSS Statistics 31.0. The Cronbach's Alpha coefficient was calculated for the items assessing ergonomic practices and musculoskeletal pain severity. The analysis yielded a reliable coefficient score, indicating an acceptable and good level of internal consistency, thus confirming the structural validity of the adapted survey instrument for the target population (Table 1).

Table 1. Reliability Statistics of the survey instrument.

Variable Category	Number of Items	Cronbach's Alpha (α)	Internal Consistency
Ergonomic Practices & Pain Indicators	6	0.784	Good / Reliable

3.2. Socio-Demographic and Occupational Characteristics

A total of 110 pediatric dentists successfully completed the survey. The sample demonstrated a balanced gender distribution, with 51.8% (n = 57) females and 48.2% (n = 53) males. The majority of the respondents belonged to the 36-45 years age group (54.5%), followed by those aged 25-35 years (25.5%). In terms of clinical experience, over half of the participants (52.7%) reported having 5 to 10

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years of practice. The private sector was the dominant practice setting, accommodating 69.1% of the dentists. Regarding daily workload, 56.4% of the participants worked 6-8 hours daily, and almost half of the sample (49.1%) treated more than 10 pediatric patients per day. Detailed demographic and occupational characteristics are presented in Table 2.

Table 2. Socio-demographic and occupational characteristics of the participants (N = 110)**.**

Variable	Category	Frequency (n)	Percentage (%)
Gender	Female	57	51.8
	Male	53	48.2
Age	25-35 years	28	25.5
	36-45 years	60	54.5
	>45 years	22	20.0
Years of Experience	<5 years	16	14.5
	5-10 years	58	52.7
	>10 years	36	32.7
Type of Practice	Private	76	69.1
	Governmental	34	30.9
Average Working Hours/Day	<6 hours	2	1.8
	6-8 hours	62	56.4
	>8 hours	46	41.8
Number of Patients/Day	<5 patients	1	0.9
	5-10 patients	55	50.0
	>10 patients	54	49.1

3.3. Ergonomic Practices and Work Habits

The evaluation of ergonomic practices revealed concerning trends among the surveyed pediatric dentists. While 52.7% utilized magnification loupes during clinical procedures, a substantial proportion (47.3%) reported not using them. Four-handed dentistry was strictly adopted by only 27.3% of the participants, whereas 35.5% reported never working with a dental assistant. Furthermore, preventive ergonomic habits were largely neglected; the vast majority of the dentists (73.6%) did not take regular breaks between patients, and 60.0% did not engage in regular stretching or physical exercise. These findings are summarized in Table 3.

Table 3. Ergonomic practices and preventive habits among pediatric dentists (N = 110).

Variable	Category	Frequency (n)	Percentage (%)
Use of Magnification (Loupes)	Yes	58	52.7
	No	52	47.3
Four-handed Dentistry	Always	30	27.3
	Sometimes	41	37.3
	Never	39	35.5
Regular Breaks Between Patients	Yes	29	26.4
	No	81	73.6
Regular Stretching or Exercise	Yes	44	40.0
	No	66	60.0

3.4. Prevalence and Anatomical Distribution of Musculoskeletal Disorders

The prevalence of work-related musculoskeletal pain over the past 12 months was alarmingly high, affecting 88.2% (n = 97) of the participants. The most frequently reported anatomical sites for pain were the neck (62.7%), shoulders (58.2%), and lower back (52.7%). The severity of the experienced pain was notably high, with a mean score of 6.31 ± 2.02 on a 10-point visual analog scale. Consequently, nearly half of the dentists (49.1%) admitted to taking sick leaves due to musculoskeletal complaints. Detailed manifestations are shown in Table 4.

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Table 4. Prevalence, anatomical distribution, and severity of MSDs over the past 12 months.

Variable	Category	Frequency (n)	Percentage (%)
Experienced WMSDs Pain	Yes	97	88.2
	No	13	11.8
Anatomical Locations*	Neck	69	62.7
	Shoulders	64	58.2
	Lower Back	58	52.7
	Upper Back	18	16.4
	Elbows	9	8.2
	Wrists/Hands	4	3.6
	Knees	2	1.8
Taken Sick Leave Due to Pain	Yes	54	49.1
	No	56	50.9
Pain Severity Score (1-10)	Mean ± SD	6.31 ± 2.02	-

**Multiple responses were allowed; percentages are calculated based on the total sample (N = 110).*

3.5. Association Between Ergonomic Practices, Demographics, and MSDs

Pearson's Chi-square (X^2) tests were employed to assess the statistical significance of associations between specific variables and the incidence of pain at various anatomical sites (Table 5). A significant gender disparity was observed, as female pediatric dentists demonstrated a significantly higher susceptibility to both neck pain ($p = 0.008$) and lower back pain ($p < 0.001$) compared to their male counterparts. Regarding ergonomic interventions, the non-utilization of magnification loupes was significantly associated with a higher incidence of neck pain ($p = 0.020$). Moreover, a highly significant inverse relationship was established between four-handed dentistry and lower back pain ($p < 0.001$); practitioners who never utilized a dental assistant reported the highest frequency of lower back pain (76.9%), contrasting sharply with those who consistently practiced four-handed dentistry (3.3%).

Table 5. Chi-square analysis associating demographics and ergonomic practices with specific MSDs.

Variable	Category	Neck Pain (Yes) n (%)	Neck Pain (No) n (%)	P-value
Gender	Female	43 (75.4%)	14 (24.6%)	**0.008***
	Male	26 (49.1%)	27 (50.9%)	
Use of Loupes	Yes	30 (51.7%)	28 (48.3%)	**0.020***
	No	39 (75.0%)	13 (25.0%)	
		Lower Back Pain (Yes)	**Lower Back Pain (No)**	
Gender	Female	41 (71.9%)	16 (28.1%)	**< 0.001***
	Male	17 (32.1%)	36 (67.9%)	
Four-handed Dentistry	Always	1 (3.3%)	29 (96.7%)	**< 0.001***
	Sometimes	27 (65.9%)	14 (34.1%)	
	Never	30 (76.9%)	9 (23.1%)	

**Statistically significant at $p < 0.05$ (IBM SPSS Statistics 31.0).*

4. Discussion

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The current study aimed to evaluate the prevalence of work-related musculoskeletal disorders (WMSDs) and the impact of ergonomic practices among pediatric dentists. The findings revealed an alarmingly high prevalence of WMSDs, with 88.2% of the surveyed practitioners reporting musculoskeletal pain within the preceding 12 months. This exceptionally high prevalence is consistent with the global and regional literature concerning dental professionals [20, 22]. For instance, a recent study by Almaaita et al. investigating dental professionals in the Jordanian Royal Medical Services reported widespread musculoskeletal pain, particularly in the neck and lower back regions, corroborating the localized occupational hazards in this geographical area [25]. Similarly, international studies, such as the research conducted by Harris et al. among Canadian dental professionals, reported a comparable WMSD prevalence of 83% [24]. The persistently high rates across different regions, including findings from Saudi Arabia and the UAE, underscore the physically demanding nature of dental practice, which is characterized by prolonged static postures and repetitive hand movements [21, 23].

A prominent and statistically significant finding in this study was the gender disparity in WMSD susceptibility. Female pediatric dentists exhibited a significantly higher vulnerability to both neck pain ($p = 0.008$) and lower back pain ($p < 0.001$) compared to their male counterparts. This outcome strongly aligns with a national cross-sectional study by Sulimany et al., which demonstrated that female dental practitioners had significantly higher odds of reporting cervical pain [28]. The elevated risk among females can be attributed to several multifactorial elements documented in the literature. Physiologically, women generally possess lower baseline muscle mass and strength in the upper body and shoulder girdle compared to men, which may accelerate muscle fatigue during sustained awkward postures [27, 29]. Furthermore, operating in dental units primarily designed for average male anthropometric dimensions further predisposes female practitioners to a higher occupational biomechanical load [28].

A pivotal aspect of the present study was evaluating the impact of specific ergonomic interventions on the prevalence of regional pain. Our statistical analysis established a significant inverse association between the utilization of magnification loupes and the incidence of cervical pain ($p = 0.020$). Practitioners who operated without magnification systems reported a considerably higher frequency of neck discomfort. This finding is strongly corroborated by contemporary ergonomic literature, which emphasizes the protective biomechanical role of magnification [32, 34]. According to Hayes et al., the integration of loupes significantly reduces neck disability among dental professionals by promoting a more upright and neutral cervical posture [34]. Furthermore, clinical assessments by Pazos et al. and Ludwig et al. demonstrated that Galilean loupes prevent excessive forward head bending and significantly decrease the angular deviation of the neck during simulated clinical procedures [30, 31]. By enhancing visual acuity, loupes eliminate the practitioner's physical need to lean forward and compromise their posture to gain better access to the operative field, thereby mitigating muscle fatigue and tension in the cervical and upper back regions [33, 35].Equally critical was the profound impact of working with a dental assistant on lumbar health. The data revealed a highly significant correlation between the absence of four-handed dentistry and the development of lower back pain ($p < 0.001$). Pediatric dentists who consistently worked alone exhibited the highest rates of lumbar complaints (76.9%), contrasting sharply with the minimal pain reported by those who always utilized an assistant. This aligns seamlessly with existing literature highlighting the biomechanical advantages of assisted dental practice [36, 38]. As emphasized in the integrative review by Bendahan Álvarez et al., the four-handed technique is paramount for minimizing unnecessary trunk twisting, overreaching, and lateral bending [38]. When operating independently, especially in pediatric dentistry where patient management requires heightened physical control, the practitioner is frequently forced into awkward, asymmetrical postures to retrieve instruments [36].

This repetitive, unassisted movement drastically increases the mechanical load and shear forces on the lumbar spine. Consequently, maintaining a neutral seated posture while a trained assistant transfers instruments within the optimal ergonomic zone is a crucial preventive strategy against chronic lower back disorders [36, 39].

The severity of the reported musculoskeletal pain in the present study directly translated into significant occupational disruption, with nearly half of the surveyed pediatric dentists (49.1%)

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requiring sick leave due to their symptoms. This finding highlights the severe socioeconomic and professional impact of WMSDs, transforming them from a mere physical discomfort into a primary cause of absenteeism and reduced clinical productivity. Consistent with our findings, Abdolalizadeh et al. emphasized that WMSDs are the leading cause of lost working days, diminished work efficiency, and early retirement among dental practitioners [49]. Furthermore, investigations into healthcare absenteeism, such as the study by Amaro et al., have documented that musculoskeletal injuries account for a substantial proportion of sickness absence, severely impacting the quality of care and increasing occupational costs [43, 45]. The physically demanding nature of pediatric dentistry, which frequently requires managing uncooperative children while maintaining static postures, exacerbates the severity of these symptoms, thereby increasing the likelihood of taking temporary leave to recover from acute pain episodes [41, 48].

Despite the high prevalence and severity of WMSDs, our data revealed a concerning negligence of preventive ergonomic strategies. A vast majority of the participants (73.6%) reported not taking regular micro-breaks between patients, and 60.0% lacked a routine of stretching or physical exercise. This widespread omission of fundamental preventive measures significantly contributes to the cumulative muscular fatigue observed in this population. The literature robustly supports the integration of active rest and stretching protocols to combat occupational pain [44, 48]. A recent clinical study by Kim et al. quantitatively demonstrated that implementing targeted stretching interventions between dental procedures significantly increased the pain pressure thresholds in the neck, shoulder, and lower back muscles, effectively relieving accumulated tension [47]. Moreover, Pejčić et al. and Shaik have stressed that the incorporation of frequent, short recovery breaks is essential to allow for muscle reperfusion and to prevent the sustained isometric contractions that lead to chronic musculoskeletal damage [44, 48]. The persistent failure to adopt these straightforward, cost-effective interventions underscores a critical gap between ergonomic knowledge and actual clinical practice among pediatric dentists [40, 49].

The current study presents several notable strengths. Primarily, it contributes valuable, context-specific epidemiological data regarding pediatric dentists, a subgroup frequently underrepresented in the broader dental ergonomics literature despite their unique occupational challenges. The use of a validated, structured assessment tool, coupled with robust statistical analyses, provides a reliable foundation for the observed associations. Furthermore, achieving a satisfactory response rate ensures that the findings are reasonably representative of the targeted clinical demographic.

However, these results must be interpreted in light of certain methodological limitations. First, the cross-sectional design of the study precludes the establishment of temporal or causal relationships between ergonomic practices and the onset of WMSDs; it only highlights significant associations. Second, the reliance on a self-administered digital questionnaire introduces the inherent risk of recall bias, as participants were required to estimate their pain severity, exact anatomical locations, and ergonomic compliance retrospectively over a 12-month period. Subjectivity in pain perception may also lead to the overestimation or underestimation of symptoms. Finally, while the sample size of 110 participants provided adequate statistical power to detect significant differences, larger, multi-centric longitudinal cohorts are recommended for future research to validate these findings and continuously monitor the long-term efficacy of specific ergonomic interventions.

5. Conclusions

Within the limitations of this cross-sectional study, it is concluded that work-related musculoskeletal disorders (WMSDs) represent a severe and highly prevalent occupational hazard among pediatric dentists. Affecting a staggering 88.2% of the surveyed practitioners, these disorders predominantly target the cervical and lumbar regions, often manifesting with high pain severity that significantly impairs daily clinical performance. The study also highlights a pronounced gender disparity, demonstrating that female pediatric dentists are significantly more susceptible to developing disabling neck and lower back pain compared to their male colleagues, necessitating greater attention to gender-specific ergonomic needs.

Furthermore, the findings firmly establish that strict adherence to fundamental ergonomic practices is mechanically crucial for occupational longevity. The consistent utilization of

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magnification loupes was proven to significantly mitigate cervical strain, while the continuous integration of four-handed dentistry serves as an indispensable protective measure against severe lower back disorders. Given the alarming rates of pain-induced sick leaves (49.1%) and the widespread negligence of routine preventive measures such as micro-breaks and physical stretching, there is an urgent need for a professional paradigm shift. It is imperative to transition from passive ergonomic awareness to the active, mandatory implementation of ergonomic protocols and preventive physical strategies in both pediatric dental education and daily clinical practice.

6. Recommendations

Based on the significant findings of this study, the following proactive and comprehensive measures are highly recommended to mitigate the burden of WMSDs among pediatric dentists:

- **Mandatory Integration of Magnification:** Dental clinics and institutions should strongly encourage or subsidize the use of magnification loupes for pediatric dentists to ensure a neutral cervical posture and prevent chronic neck strain.
- **Adoption of Four-Handed Dentistry:** Clinic management must prioritize the consistent availability of trained dental assistants for pediatric practitioners, as working alone was proven to be a primary catalyst for severe lower back pain.
- **Implementation of Ergonomic Micro-Breaks:** Practitioners must consciously integrate short, active recovery breaks and targeted stretching exercises between pediatric appointments to relieve cumulative muscle tension and prevent physical burnout.
- **Optimization of Operator Seating:** Dental facilities should invest in ergonomically designed operator stools, such as saddle-style seats, which promote a natural lumbar curve, maintain proper pelvic tilt, and reduce spinal compression during prolonged treatments.
- **Workload Diversification and Scheduling:** Clinic administrators should optimize daily appointment scheduling by alternating physically demanding or uncooperative pediatric cases with less strenuous consultations, thereby preventing sustained periods of muscle fatigue.
- **Optimal Patient Positioning:** Dentists must be continuously trained to adjust the pediatric dental chair and the patient's head positioning effectively, ensuring the operative field is brought to the dentist rather than the dentist bending toward the patient.
- **Curriculum Reformation:** Dental schools and specialty training programs should incorporate practical, gender-sensitive ergonomic training into their core curricula, ensuring that future pediatric dentists adopt healthy biomechanical habits early in their careers.

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Informed Consent Statement: Digital informed consent was obtained from all subjects involved in the study prior to their participation in the survey.

Data Availability Statement: The data presented in this study are available within the article.

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Abbreviations

MSDs: Musculoskeletal Disorders **WMSDs:** Work-Related Musculoskeletal Disorders **SPSS**: Statistical Package for the Social Sciences **IRB:** Institutional Review Board

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