Cost and disability trends of work-related musculoskeletal disorders in Ohio

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**Background**

With expected changes in age demographics many industry sectors may see their workforce significantly increase in age. The impact of claims and costs associated with musculoskeletal disorders in these industries may also change accordingly.

**Aims**

To determine the age-related trends in musculoskeletal disorders, including claims and costs, in different industrial sectors in the state of Ohio, USA.

**Methods**

Worker’s compensation claims for musculoskeletal disorders in the state of Ohio between 1999 and 2004 were analysed in respect of age, industry sector, body region, and impact on cost and medical care (percentage of claims associated with surgery and number of procedures costing in excess of US$600).

**Results**

More than 570,000 claims were analysed. Patterns of cost and disability among the majority of body regions demonstrated an increasing trend until 55 years of age, decreasing in older age groups. However, many industries demonstrated a continued increasing trend in costs with age. Shoulder and lumbar spine disorders showed unique industry-specific trends for older age groups as compared to the bell-shaped relationships for other body regions.

**Conclusions**

Ageing appeared to have a role in the frequency and costs of musculoskeletal disorder claims in this study. However, industry-specific trends in the data suggest that job-specific risk factors may also play a role. The impact of age alone on the cost of musculoskeletal disorders cannot be determined because age is confounded by numerous lifestyle and work-related factors not identifiable in this study.

**Key words**

Disability; injury costs; worker compensation.

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**Introduction**

Due to changing population demographics and delays in retirement many industry sectors in the USA have been ageing significantly older. The number of individuals between the ages 55 and 64 working in industry has increased by 7.5 million (a 54% increase) between 2000 and 2010 while the number of workers above the age of 65 has increased by 2 million (a 49% increase) [1]. This upward shift in working age may continue since the population above the age of 65 is expected to double in the next 30 years [2]. As ‘baby boomers’ become 65 or older, a majority (80%) are planning to work after retirement age [3]. Furthermore, the recent economic crisis and resulting changes to retirement age mean workers are staying in the workforce longer.

Work-related musculoskeletal disorders (MSDs) in the USA have adversely affected the private sector with about 320,000 ‘lost work day cases’ per year, representing 29% of all lost day injury and illness claims [4]. Among these MSDs the body regions involved were low back (48%), shoulder (13%), upper extremities 1 (5%), knee (5%), ankle or foot (2%) and multiple sites (5%) [4]. Dunning et al. [5] reported the majority of costs for MSDs to be related to lumbar spine and hand or wrist injuries, predominantly occurring in the manufacturing and service industries. Costs for MSDs exceed those of cancer and are exceeded only by cardiovascular disease and acute
injury costs [6]. Estimates of the annual economic burden of MSDs in the USA are between $45 and 54 billion [7]. Older workers may be more susceptible due to diminished capacities, including reduced muscle strength (about 10% per decade) [8–11]; decreased joint mobility and tissue elasticity [12–15]; decreased lumbar spine mobility inducing alterations in muscle recruitment [12,13,16]; structural changes in the spine and load-bearing joints [12]; a decline in sensory-motor responses [13,17] and decreases in cognitive processes such as memory, attention and primary processing [18–20]. In all, many components of the human body deteriorate with ageing, potentially resulting in adverse responses leading to MSDs as well as deterioration in tissues from years of cumulative exposure.

Previous research has found older workers have lower rates of injury [21], potentially indicating a healthy worker effect. Older workers (aged 45–65) have been found to suffer chronic disorders and co-morbidities [21]. Ageing may also be one of the factors related to costs of MSDs. Older workers potentially sustain more severe injuries leading to longer recovery times and more lost days, increasing the cost of resulting claims [21,22]. In the most severe cases, older workers appear more likely to receive permanent or partial disability benefits than temporary benefits, also resulting in increased worker compensation costs [23].

While there appears to be a higher risk of MSDs in older workers due to cumulative trauma and declining capacities there are only a few studies that have investigated trends in MSD compensation costs across age groups [24,25]. These focused on global trends rather than individual industries. Therefore the purpose of this study was to determine the trends for different age groups across industries using state-affiliated workers’ compensation data from 1999 to 2004: frequency, costs, disability and medical care. The age-related relationships were explored in individual industry sectors to determine whether sector-specific demands may influence the effect of age. While actual exposures cannot be identified in the industry-based analyses differences may suggest factors beyond the natural ageing process were involved.

Methods

We created a database which included detailed information about the claims submitted to the Ohio Bureau of Workers’ Compensation (OBWC) from 1999 to 2004. All resulting costs up to 31 December 2005 were included, so some claims were censored and not fully matured (i.e. remained open). OBWC covers about 70% of employers in Ohio. Relevant claims were defined by a musculoskeletal ICD-9 code. All claims required the claimant to be at least 16 years old. Excluded claims included lacerations, acute trauma and fractures. Age was reported at the time of the claim and converted into six age groups: 16–24, 25–34, 35–44, 45–54, 55–64, and 65 and over. Each claim was classified based on the body regions involved: upper extremity, including hand, wrist and elbow; shoulder; cervical spine; lumbar spine and knee (Appendix 1, available as Supplementary data at Occupational Medicine Online). In some claims multiple body regions were specified, in which case analysis used the most severe ICD-9 code with respect to days lost. To determine if older claimants were more likely to have degenerative conditions chronic diagnoses were defined by ICD codes for shoulder, knee, cervical spine and lumbar spine claims (Appendix 2, available as Supplementary data at Occupational Medicine Online). The study was reviewed by the University of Cincinnati Institutional Review Board. For industry classification, the industrial classification codes used by the OBWC were converted manually into industrial sector codes based on North America Industry Classification System (NAICS) codes. The industry sector categories included: manufacturing; construction; transportation, warehouse and utilities (TWU); wholesale and retail trade (WRT); service and health care and social assistance (health/social).

Outcome measures were: (i) total cost per claim (i.e. the sum of medical costs and indemnity costs), (ii) total medical costs (i.e. the direct costs of medical treatment), (iii) total indemnity costs (i.e. the salary paid directly to worker, not including other costs such as replacement workers), (iv) percentage of claims with greater than 7 days lost work, (v) number of lost days per claim, (vi) percentage of procedures exceeding US$600 in cost and (vii) percentage of claims associated with surgery (based on Current Procedural Terminology codes). In order to compare categorical variables across age categories (i.e. claims with >7 days lost work, procedures >$600 or involving surgery), a chi-square test for trend was used. In order to compare continuous outcomes (cost and days of lost work) across age categories, SAS PROC GLM was used to conduct an analysis of variance (ANOVA). In order to determine which age categories differed, Tukey’s multiple comparisons tests for pairwise differences between age categories were conducted to minimize Type I error. All statistics were performed using SAS. Statistical significance was defined as P ≤ 0.05.

For ~10% of claims a return to work date was missing. This missing data suggests either that the claimant did not return to work or that the return to work date was not entered into the administrative database. For this analysis, one of two options was used to calculate days lost for these claims: (i) a temporary total (TT) indemnity ending date was used as the return to work date, or (ii) where no TT ending date existed the claimant was assumed to not have returned to work.

Results

Over half (55%) of the 572508 MSD claimants were between the ages of 25 and 44 (Figure 1). The number of claims followed a bell-shape trend across age groups,
with the lowest number of MSDs among claimants aged 65 and older (1%) followed by those aged 16–24 (16%). Table 1 summarizes the overall age-related trends for all claims. Male MSD claimants outnumbered females almost 2 to 1 among claimants less than 44 years old while the distribution approached 1 to 1 with increasing age.

![Pie chart showing age distribution of MSD claims.]

**Figure 1.** Percent of claims of the 572,508 musculoskeletal disorder claims in each of the age groups.

**Table 1.** Worker characteristics and average costs per claim as a function of age: 1999–2004 OBWC musculoskeletal claims

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Gender</th>
<th>n (%)</th>
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<th>n (%)</th>
<th>Gender</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35–44 (n = 162,039)</td>
<td>Male</td>
<td>73 (349)</td>
<td>Female</td>
<td>86 (356)</td>
<td>Male</td>
<td>99 (359)</td>
<td>Female</td>
<td>92 (332)</td>
<td>Male</td>
<td>86 (318)</td>
<td>Female</td>
<td>86 (312)</td>
<td>Male</td>
<td>89 (348)</td>
<td>Female</td>
<td>89 (348)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>45–54 (n = 113,320)</td>
<td>Male</td>
<td>4107 (5)</td>
<td>Female</td>
<td>10,744 (7)</td>
<td>Male</td>
<td>15,110 (11)</td>
<td>Female</td>
<td>18,221 (11)</td>
<td>Male</td>
<td>15,040 (913)</td>
<td>Female</td>
<td>6007 (14)</td>
<td>Male</td>
<td>12,2 (794)</td>
<td>Female</td>
<td>12,2 (794)</td>
<td>Male</td>
<td>12,2 (794)</td>
<td>Female</td>
<td>12,2 (794)</td>
<td>Male</td>
<td>12,2 (794)</td>
<td></td>
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</tr>
<tr>
<td>55–64 (n = 42,424)</td>
<td>Male</td>
<td>2,660 (3)</td>
<td>Female</td>
<td>1,0474 (7)</td>
<td>Male</td>
<td>18,221 (11)</td>
<td>Female</td>
<td>18,221 (11)</td>
<td>Male</td>
<td>15,040 (913)</td>
<td>Female</td>
<td>6007 (14)</td>
<td>Male</td>
<td>12,2 (794)</td>
<td>Female</td>
<td>12,2 (794)</td>
<td>Male</td>
<td>12,2 (794)</td>
<td>Female</td>
<td>12,2 (794)</td>
<td>Male</td>
<td>12,2 (794)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65+ (n = 6525)</td>
<td>Male</td>
<td>1,746 (2)</td>
<td>Female</td>
<td>7,821 (5)</td>
<td>Male</td>
<td>13,852 (9)</td>
<td>Female</td>
<td>12,108 (11)</td>
<td>Male</td>
<td>5,148 (12)</td>
<td>Female</td>
<td>633 (10)</td>
<td>Male</td>
<td>41,308 (7)</td>
<td>Female</td>
<td>41,308 (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

SD, standard deviation.

5316 claims missing gender.
Although all claims and cost outcomes increased significantly ($P < 0.001$) with age, they decreased in the 65 and over age group. Workers aged 16–24 and 25–34 had the lowest percentage of claims with days lost, claims resulting in medical procedures costing over $600 and claims resulting in surgery, and the lowest costs. Workers aged 45–54 and 55–64 had the highest percentage of claims resulting in lost work days, procedures costing over $600 and surgery, and the highest costs. Overall, 7% of claims were associated with a surgical procedure, increasing steadily with age to 12% in the 55–64 age group. The percentage of claims involving surgery more than doubled for claimants aged 45 and older as compared to those aged 34 and under.

The average overall cost per claim was $5130, increasing with age until 45–54 ($6993) and then decreasing. There was a significant 3-fold or greater increase in average total cost per claim when comparing the youngest group (16–24) to the older groups (35 and over). The proportion decreased from 67% (16–24) to 59% (25–34) to 56% (35–44) to 55% (45–54) to 55% (55–64), and was higher for 65+ (57.9%). The percentage of medical costs as a proportion of total costs decreased from about 68% for the 16–24 age group to ~55% for the 35 and over age group ($P < 0.05$). Age-related trends in average total cost per claim were driven by both body region and industry sector (Figure 2). Lumbar spine and shoulder injuries consistently involved the greatest cost burden in the older age groups, followed by cervical spine, knee and upper extremity MSDs (Table 2).

The average total cost for lumbar spine claims showed a steep increase between the youngest group (16–24) and the next two age groups (25–34 and 35–44), with a levelling off across the next two age groups (45–54 and 55–64), and finally a decline for the oldest group (65 and over). The increase in cost with age was most dramatic for the TWU industry ($P < 0.05$), whereas in the oldest group in manufacturing industry there was a decline in

![Diagram](https://www.oup.com/academic/doi/10.1093/occmed/kqz007)
Figure 2. Average total costs (medical and indemnity) per claim for musculoskeletal disorders in body regions: (a) elbow, hand or wrist, (b) knee, (c) shoulder, (d) cervical spine and (e) lumbar spine as a function of industry sectors: manufacturing, service, health and social services, WRT, TWU and construction.
the total average cost by more than half. Among WRT and TWU claims, the highest cost ($P < 0.05$) was among workers aged 35–44. The prevalence of a chronic lumbar spine diagnosis steadily increased with age with the highest percent among those aged 55 and over (Table 2).

Cervical spine MSD costs were similar between industries for the younger age groups (16–24, 25–34 and 35–44) ($P > 0.05$) (Table 2). All industries experienced the largest increase in costs from 25–34 and 35–44 for the cervical spine. Highest cost age groups were 35–44 (manufacturing, service) and 45–54 (health/social, WRT, TRU, construction). In general, the average total cost for cervical spine MSDs significantly decreased in older groups but the magnitude of the reduction depended on the industry.

Shoulder costs differed slightly from the other body regions, showing a persistent increase through all age groups for manufacturing, service, and WRT. The TWU and health/social industries were the only industries that had a significant decrease in average cost per claim for the 65 and over group. Furthermore among all industries except construction the highest costs were in either the 55–64 or 65 and over age groups (Table 3). Although the overall average cost per claim decreased for those aged 65 and over they had the highest percentage of claims resulting in over 7 days lost work, procedures costing over $600 and surgery (Table 2).

### Discussion

The annual total cost of MSDs to Ohio’s workers’ compensation system was nearly $3 billion. Costs for all MSDs followed an increasing trend up to 64 years old with the highest costs and disability among claimants aged 45–54 and 55–64, with a levelling off of costs for those aged 65 and over. In this respect claimants aged 65 and over were comparable to those aged 35–44. While it is difficult to attribute any trends to specific causes there are many potential factors that may have caused the observed trend and the levelling off in the oldest group: (i) the ‘healthy worker’ effect where healthy workers stay employed whereas those injured, or with more significant health problems (e.g. cardiac disease, vascular disorders or cancer) or age-related decrements leave the workforce; (ii) older individuals may retire without surgery; and (iii) older workers may move to less physically demanding jobs due to seniority. Researchers at Safety & Health Assessment & Research for Prevention (SHARP) reported a similar bell-shaped trend for combined MSD injuries but also found trends for neck, back and upper body issues.

### Table 2. Percent of claims with chronic diagnoses for knee, cervical spine and lumbar spine claims report to the Ohio Bureau of Workers’ Compensation 1999–2004

<table>
<thead>
<tr>
<th>16–24</th>
<th>25–34</th>
<th>35–44</th>
<th>45–54</th>
<th>55–64</th>
<th>65+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee, n</td>
<td>12592</td>
<td>21752</td>
<td>24218</td>
<td>21062</td>
<td>9243</td>
<td>1644</td>
</tr>
<tr>
<td>Internal derangement, n (%)</td>
<td>665 (5)</td>
<td>2147 (9)</td>
<td>3520 (14)</td>
<td>3793 (17)</td>
<td>1721 (18)</td>
<td>208 (12)</td>
</tr>
<tr>
<td>Arthritis, n (%)</td>
<td>4 (0)</td>
<td>10 (0)</td>
<td>49 (0)</td>
<td>84 (0)</td>
<td>60 (1)</td>
<td>9 (1)</td>
</tr>
<tr>
<td>Cervical spine, n</td>
<td>3933</td>
<td>8560</td>
<td>9686</td>
<td>6557</td>
<td>2305</td>
<td>409</td>
</tr>
<tr>
<td>Chronic diagnosis, n (%)</td>
<td>12 (0)</td>
<td>86 (1)</td>
<td>354 (3)</td>
<td>371 (5)</td>
<td>146 (6)</td>
<td>28 (6)</td>
</tr>
<tr>
<td>Lumbar spine, n</td>
<td>23154</td>
<td>43463</td>
<td>47354</td>
<td>30643</td>
<td>10379</td>
<td>1287</td>
</tr>
<tr>
<td>Chronic diagnosis, n (%)</td>
<td>83 (0)</td>
<td>384 (1)</td>
<td>1059 (2)</td>
<td>1053 (3)</td>
<td>521 (6)</td>
<td>80 (6)</td>
</tr>
</tbody>
</table>

*Chronic diagnosis is defined as claims that are related to long-term diagnosis such as arthritis, tendonitis and herniated or bulging discs.

### Table 3. Shoulder claims reported to the Ohio Bureau of Workers’ Compensation 1999–2004

<table>
<thead>
<tr>
<th>16–24</th>
<th>25–34</th>
<th>35–44</th>
<th>45–54</th>
<th>55–64</th>
<th>65+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n = 10015)</td>
<td>(n = 18926)</td>
<td>(n = 21274)</td>
<td>(n = 16096)</td>
<td>(n = 7017)</td>
<td>(n = 1235)</td>
<td>(n = 74563)</td>
</tr>
<tr>
<td>Total cost per claim ($)</td>
<td>1534 (6195)</td>
<td>3717 (12283)</td>
<td>6579 (17561)</td>
<td>9253 (21531)</td>
<td>10130 (20131)</td>
<td>9564 (19345)</td>
</tr>
<tr>
<td>(SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days lost</td>
<td>93 (395)</td>
<td>102 (391)</td>
<td>121 (398)</td>
<td>121 (363)</td>
<td>127 (364)</td>
<td>113 (319)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>1488 (15)</td>
<td>4453 (24)</td>
<td>6840 (32)</td>
<td>6055 (38)</td>
<td>2835 (40)</td>
<td>504 (41)</td>
</tr>
<tr>
<td>Percent of claims &gt;7 days lost work, n (%)</td>
<td>0.2 (0.9)</td>
<td>0.5 (1.7)</td>
<td>0.9 (2.5)</td>
<td>1.4 (3.1)</td>
<td>1.6 (3.0)</td>
<td>1.6 (3.1)</td>
</tr>
<tr>
<td>Medical procedures costing &gt;$600</td>
<td>0.2 (0.9)</td>
<td>1511 (8)</td>
<td>3122 (15)</td>
<td>3468 (22)</td>
<td>1822 (26)</td>
<td>337 (27)</td>
</tr>
<tr>
<td>Percent claims ≥2, n (%)</td>
<td>0.2 (0.9)</td>
<td>1511 (8)</td>
<td>3122 (15)</td>
<td>3468 (22)</td>
<td>1822 (26)</td>
<td>337 (27)</td>
</tr>
<tr>
<td>Surgery, n (%)</td>
<td>164 (2)</td>
<td>1063 (6)</td>
<td>2403 (11)</td>
<td>2898 (18)</td>
<td>1367 (23)</td>
<td>290 (24)</td>
</tr>
<tr>
<td>Chronic diagnosis, n (%)</td>
<td>542 (5)</td>
<td>1631 (9)</td>
<td>2574 (12)</td>
<td>2149 (13)</td>
<td>795 (11)</td>
<td>101 (8)</td>
</tr>
</tbody>
</table>

*Chronic diagnosis is defined as claims that are related to long-term diagnosis such as arthritis, tendonitis and rotator cuff.
The general trend in claim costs typically increased [26]. In all the trends in claim costs observed in this study were very similar to SHARP data.

One interesting statistic was that almost 25% of the MSDs claims in the older groups (45 years and over) resulted from indemnity costs, which appears to have been driven by lost working days and surgery. The percentage of MSDs that resulted in seven or more lost days was at or above 30% for age groups above 45, which translated to an average of more than 80 days per claim. The percentage of claims that required surgery peaked for the 55–64 age group but was also elevated for the 35–44, 45–54 and 65 and over age groups (above 9%). Similar age-related trends for lost workdays (claims with over seven lost days) due to MSDs for private industry indicated that more lost day claims occurred in the older age groups [1].

The most interesting results from this study were the trends for body region specific MSDs as a function of industry (Figure 2). While the overall trends (mainly for upper extremity, cervical and knee MSDs) were bell-shaped, not all body regions resulted in declining costs in the older groups. One divergent trend was for the shoulder where the costs increased until about 6 years old in many industries with a small decrease in the oldest age group, specifically manufacturing, service and WRT. Lumbar spine cases also had a levelling of costs for the older ages but it started at an earlier age.

The current study provides a snapshot of the frequency and costs due to MSDs within the OBWG programme. However, the data failed to provide an understanding of causal effects due to lack of data on factors such as biomechanical, psychosocial, physiological or work organizational stressors, as well as cross-sectional nature of the data. Some evidence that industry-specific stressors drive frequency and costs is provided by the different trends across body regions for different industries. The TWU industry had some of the highest average costs per claim, particularly relating to lumbar spine (above $15,000 for age groups 35 and over), shoulders (above $14,000 in those aged 45 and over), and cervical spine (above $11,000 for the 35–44 and 45–54 age groups). The more costly claims may indicate more demanding jobs and physical exposures with higher risk of MSDs. In the warehousing subsector of the TWR industry workers handle large amount of product using material handling practices that place significant loads on the body [27]. The prevalence of more expensive MSDs claims involving the shoulder and lower lumbar spine in the manufacturing, construction and WRT industries may represent a change in work design where the burden on the lower back was reduced but more stress was placed on the shoulders.

Several limitations of the study need to be considered. Firstly, claims represent reported MSDs and may not fully reflect the entire burden to industry. Under-reporting is commonplace in compensation systems where workers may not report injuries due to continued employment issues [28,29]. Secondly, given the cross-sectional nature of the data, the medical and indemnity costs may not represent final costs as all claims were censored at 31 December 2005, probably resulting in an underestimation of the costs. Thirdly, several key pieces of information were not recorded in the claim data, namely: (i) co-morbidities, (ii) mechanism of injury and (iii) number of workers exposed. Lack of co-morbidity and mechanism of injury data makes it difficult to identify exact cause of the MSDs. Fourthly, the lack of knowledge on the number of individuals exposed precludes estimating MSD rates, further complicating the understanding of their impact. Since only ~70% of all Ohio workers are covered by the Ohio workers’ compensation system, there are no existing databases that can provide the distribution of workers in each industry. The total numbers within a job sector would not affect the average cost per claim across job sectors and age groups. Finally, ICD coding is subject to inaccuracies due to variations in diagnostic accuracy and in clinical decisions regarding diagnostic methods [30]. The potential for inaccurate ICD assignment was minimized by standardized physician examinations and diagnostic processes [30]. These limitations are typical of compensation data and need to be kept in mind in interpreting the results.

Our results provided an intriguing picture of the financial burden of workers’ compensation claims as a function of age across industries. The number of claims and the associated cost of MSDs increased as a function of age until the later years (65 and over) of work when a decline was seen. However, this trend is not universal and depended greatly on industry and MSD body region. Trends across industries cannot be directly attributed to ageing alone due to limits in the available data, the cross-sectional nature of the study and potential variations in work-related demands.

Key points

- Musculoskeletal disorders have a tremendous financial burden on workers’ compensation systems, costing more than $3 billion annually in the US state of Ohio.
- The general trend in claim costs typically increased until the age of 64 and then levelled off for most body regions.
- Trends in costs were not consistent across different industries and thus may indicate industry-specific risk factors.

Funding

Ohio Bureau of Workers’ Compensation.
Conflicts of interest

Dr Jewell worked for the Ohio Bureau of Workers’ Compensation at the time the study was completed but states no direct involvement in the analyses.

References