Age, occupational demands and the risk of serious work injury

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Background  Interest in the relationship between age and serious work injury is increasing, given the ageing of the workforce in many industrialized economies.

Aims  To examine if the relationship between age and risk of serious musculoskeletal injury differs when the physical demands of work are higher from those when they are lower.

Methods  A secondary analysis of workers’ compensation claims in the State of Victoria, Australia, combined with estimates of the insured labour force. We focused on musculoskeletal claims, which required 10 days of absence or health care expenditures beyond a pecuniary threshold. Regression models examined the relationship between age and claim-risk across workers with different occupational demands, as well as the relationship between occupational demands and musculoskeletal claim-risk across different age groups.

Results  Older age and greater physical demands at work were associated with an increased risk of musculoskeletal claims. In models stratified by occupational demands, we observed the relationship between age and claim-risk was steeper when occupational demands were higher. We also observed that the relationship between occupational demands and risk of work injury claim peaked among workers aged 25–44, attenuating among those aged 45 and older.

Conclusions  This study’s results suggest that although older workers and occupations with higher demands should be the targets of primary preventive efforts related to serious musculoskeletal injuries, there may also be gains in targeting middle-aged workers in the most physically demanding occupations.

Key words  Age; epidemiology; health and safety; occupational injury; working conditions.

Introduction

The Australian labour force is getting older. The past two decades have seen large increases in the proportion of the population who are over the age of 55, as well as labour market participation rates among older Australians [1]. In 2011, it is estimated that there were almost 2 million workers over the age of 55 in the Australian labour market, up from just under three quarters of a million in 1991. The proportion of the labour market aged over 55 has risen from 9 to 16% over the same period [2]. The ageing of the workforce has implications for the burden of work-related injury. Epidemiological research on work-related injury has generally documented that the risk of injury decreases with age, in particular among men [3,4]. Similarly, self-reported injury data show an increased risk of injury associated with younger age [5]. However, analyses of the relationship between age and workplace injury using compensation claims records in the Australian state of Victoria show an increased risk associated with older age [6]. This discrepancy could be due to older workers being more likely to report injuries for compensation purposes, even after the same injury [7,8], to older workers having more severe work injuries [9–11] or to older workers taking longer to recover from injury compared with their younger counterparts. The growing number of older workers in the labour market has led to increased interest in this group from both primary and secondary prevention perspectives.
The relationship between age and injury at work probably varies depending upon occupational conditions [12]. When certain occupational conditions are present, the excess risk among younger workers either may not be present or may be reversed. For example, a study of workers within the first month of employment in Ontario, Canada, reported that older workers had a slightly higher risk of lost-time injury than younger workers; although younger workers were at higher risk of injury after employment for more than 1 year [12]. A more recent study from France reported that the impact of self-reported physical job demands on self-reported injury was greatest among workers aged 45 and older and lowest among workers aged under 30, suggesting an interplay between physical demands and age on the risk of injury [13].

In Victoria, Australia, WorkSafe Victoria covers ~85% of the labour market for wage replacement and health care expenditures associated with injuries and illnesses deemed to be work related. The system requires that an injury accrues 10 days of work absence, or results in health care expenditure beyond a monetary threshold for it to be considered a ‘standard’ claim. Standard claims can therefore be considered a subset of work-related injuries and illnesses that are more severe in their nature.

This study aimed to examine whether the relationship between age and risk of serious work injury was moderated by occupational physical demands in Victoria. We hypothesized that both older age and greater occupational demands are associated with an increased risk of serious work injury and that the risk of serious injury at work among older workers is exacerbated by high physical work demands. We focused on musculoskeletal injuries because the occupational exposure in our study was based on physical demands and we would expect this exposure would be more strongly associated with musculoskeletal than non-musculoskeletal injuries. In addition, recent studies have reported that the relationship between age and risk of injury differs according to the nature of injury, with workers over 25 having a higher risk of musculoskeletal injury [9,14] as opposed to the more common pattern of higher overall injury risk among younger workers. Understanding whether the relationship between age and risk of serious work injury is moderated by physical work demands has potentially important implications for the primary prevention of work-related injury in the ageing workforce. If age is a risk factor for occupational injury in physically demanding roles, job-specific age limits should be recommended based on the physical demands of the job.

**Methods**

The injury data in this study were based on WorkSafe Victoria [15] claims data from the Compensation Research Database held at the Institute for Safety, Compensation and Recovery Research in Melbourne, Australia. The Monash University Human Research Ethics Committee gave approval for use and disclosure of the claims information.

We utilized standard claims accepted by WorkSafe Victoria for employees with injury dates between 1 January 2008 and 31 December 2011. A claim is considered a standard claim only after 10 days have been lost from work or a threshold of health care expenditure has been reached ($610 in the 2011/12 financial year). Data for each compensation claim include the age of the claimant, their gender and their occupational title, which is coded to the Australian and New Zealand Standard Occupational Classification (ANZSCO) [16]. To calculate claim rates across age and occupational groups, we used denominators of the insured labour force from Safe Work Australia’s National Dataset for Compensation-Based Statistics. The denominator data are derived principally from the Australian Bureau of Statistics Labour Force Survey (LFS) [2] and adjusted to account for differences in scope between the LFS and workers’ compensation coverage. The largest adjustment is for workers who have more than one job (multiple job holders), as a person holding two or more jobs may lodge a worker’s compensation claim for an illness or injury incurred in any of those jobs. As such hours of work are assigned to each specific occupation worked by a given person and these estimates are used when calculating incidence rates. Other adjustments aim to ensure correct industry coding for employees working under labour hire arrangements. Finally, workers who are self-employed or employed by the Federal Government are removed from the Victorian labour force estimates, as neither of these groups are covered for work-related injuries by WorkSafe Victoria. There is also a small group of workplaces, called self-insurers, not covered by WorkSafe Victoria [17], but as this coverage is workplace-based and spans different industry groups, it is not possible to remove these respondents from the LFS estimates. As such the rates presented in this paper will be slightly under-estimated, although we have no reason to expect that this would preferentially bias rates across age or occupational groups. Insured labour force estimates were generated across age by gender and by occupation for each financial year from 2008 to 2011. The age of the claimant was defined as the age at time of injury using the claim record. Age was grouped into the following categories: 15–24, 25–34, 35–44, 45–54 and 55 and over.

Occupational physical demands were assigned to each claimant based on the ANZSCO code associated with each claim. As there is no currently available system for assigning strength requirements in Australia, this was done using a cross-walk (i.e. application of a system to another data set with similar features) between the ANZSCO and the Canadian National Occupational
classification (NOC) system. The NOC assigns occupational characteristics, including physical demands, to each occupational title in the NOC using trained occupational analysts, generated using a modified Delphi procedure [18]. A high level of construct validity between the ANZSCO assigned physical demands and self-reported occupational demands from the National Hazard Exposure Worker Surveillance Survey [19] has previously been demonstrated [20]. Occupational physical demands are grouped into the following four levels: limited (handling loads up to 5 kg); light (handling loads of 5 but <10 kg); medium (handling loads between 10 and 20 kg) and heavy (handling loads >20 kg).

All analyses were performed using SAS software version 9.3. Initial descriptive analyses examined the number and rate of injuries across age and occupational physical demand groups. We calculated separate estimates for musculoskeletal versus non-musculoskeletal injuries, using The Nature of Injury/Disease Classification System for Victoria [21]. A series of regression models then examined the relationship between age, occupational demands and risk of injuries. The labour force participation data available were group-level (aggregate) data stratified by age, gender, occupation and year. The modelling was therefore conducted with claims per age group, gender, occupation and year as the outcome, with the exposure data included as an offset. The offset was the logged value for the number of full-time equivalents within the respective category.

To examine whether the relationship between age and risk of musculoskeletal injury differed when occupational demands were high compared with when they were low, models were constructed to examine the relationship between age and risk of injury for light/limited demand occupations compared with medium/heavy demand occupations. These models were adjusted for gender and time period of injury. Across the models, estimates for age groups were then compared using methods that take into account the size of the estimate and the confidence limits around the estimate [22,23]. For completeness, we also examined the relationship between occupational demands and risk of work injury across age groups. This analysis was completed in the same way as for the analysis comparing age and risk of work injury across occupational groups described previously.

**Results**

Table 1 presents the number of claims, claim rates and hazard ratios associated with age, occupational physical demands and year of injury for both musculoskeletal and non-musculoskeletal compensation claims. Older age was associated with a higher risk of work injury claims for both musculoskeletal and non-musculoskeletal conditions, although the strength of the relationship appeared slightly stronger for musculoskeletal conditions. Similarly, higher occupational physical demands were associated with a higher rate of claims for both types of conditions, with a slightly stronger relationship observed for occupational physical demands and risk of musculoskeletal, compared with non-musculoskeletal, conditions. Over the years 2008–11, the number of musculoskeletal as well as non-musculoskeletal claims dropped, whereas the total full-time equivalents worked

<table>
<thead>
<tr>
<th>Age group</th>
<th>Claims (MSK)</th>
<th>Claims (non-MSK)</th>
<th>FTEs</th>
<th>Rate per 1000 FTEs</th>
<th>HR (MSK)</th>
<th>95% CI (MSK)</th>
<th>Rate per 1000 FTEs</th>
<th>HR (non-MSK)</th>
<th>95% CI (non-MSK)</th>
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<tbody>
<tr>
<td>15–24</td>
<td>4450</td>
<td>5346</td>
<td>1152345</td>
<td>3.86</td>
<td>Ref</td>
<td>4.64</td>
<td>Ref</td>
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<tr>
<td>25–34</td>
<td>11032</td>
<td>9792</td>
<td>1997227</td>
<td>5.52</td>
<td>1.43</td>
<td>1.38–1.48</td>
<td>4.90</td>
<td>1.06</td>
<td>1.02–1.09</td>
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<tr>
<td>35–44</td>
<td>15988</td>
<td>12338</td>
<td>1909613</td>
<td>8.37</td>
<td>2.17</td>
<td>2.10–2.24</td>
<td>6.46</td>
<td>1.39</td>
<td>1.35–1.44</td>
</tr>
<tr>
<td>45–54</td>
<td>19198</td>
<td>15023</td>
<td>1858601</td>
<td>10.33</td>
<td>2.67</td>
<td>2.59–2.76</td>
<td>8.08</td>
<td>1.74</td>
<td>1.69–1.80</td>
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<td>55 and over</td>
<td>12168</td>
<td>12790</td>
<td>1105939</td>
<td>11.00</td>
<td>2.85</td>
<td>2.75–2.95</td>
<td>11.56</td>
<td>2.49</td>
<td>2.41–2.57</td>
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<tr>
<td>Occupational strength requirements</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Limited</td>
<td>20799</td>
<td>19893</td>
<td>5226670</td>
<td>3.98</td>
<td>Ref</td>
<td>3.81</td>
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<tr>
<td>Light</td>
<td>17152</td>
<td>15550</td>
<td>1247746</td>
<td>13.75</td>
<td>3.45</td>
<td>3.39–3.52</td>
<td>12.46</td>
<td>3.27</td>
<td>3.21–3.34</td>
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<tr>
<td>Medium</td>
<td>17425</td>
<td>14121</td>
<td>1247662</td>
<td>13.97</td>
<td>3.51</td>
<td>3.44–3.58</td>
<td>11.32</td>
<td>2.97</td>
<td>2.91–3.04</td>
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<tr>
<td>Heavy</td>
<td>7460</td>
<td>5725</td>
<td>301646</td>
<td>24.73</td>
<td>6.21</td>
<td>6.05–6.38</td>
<td>18.98</td>
<td>4.99</td>
<td>4.84–5.14</td>
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<tr>
<td>Year</td>
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<td></td>
<td></td>
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<tr>
<td>2008</td>
<td>16284</td>
<td>14074</td>
<td>1947277</td>
<td>8.36</td>
<td>Ref</td>
<td>7.23</td>
<td>Ref</td>
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<tr>
<td>2009</td>
<td>15101</td>
<td>13623</td>
<td>1952693</td>
<td>7.73</td>
<td>0.92</td>
<td>0.90–0.95</td>
<td>6.98</td>
<td>0.97</td>
<td>0.94–0.99</td>
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<tr>
<td>2010</td>
<td>15904</td>
<td>13811</td>
<td>2022900</td>
<td>7.86</td>
<td>0.94</td>
<td>0.92–0.96</td>
<td>6.83</td>
<td>0.94</td>
<td>0.92–0.97</td>
</tr>
<tr>
<td>2011</td>
<td>15547</td>
<td>13781</td>
<td>2100854</td>
<td>7.40</td>
<td>0.88</td>
<td>0.87–0.90</td>
<td>6.56</td>
<td>0.91</td>
<td>0.89–0.93</td>
</tr>
</tbody>
</table>

CI, confidence interval; FTEs, full-time equivalents; HR, hazard ratio; MSK, musculoskeletal.

*1 FTE = 2000 hours of work.
increased. Overall, claim rates therefore decreased during this period.

Table 2 presents the hazard ratios for age group and risk of musculoskeletal claims separately for occupations with lower and higher physical demands after adjustment for gender and year of injury. Differences were present in the relationship between age and risk of injury claims across occupations, with a stronger relationship observed between age and risk of musculoskeletal claims for occupations with higher demands. Differences in the risk of musculoskeletal claims were observed across all age groups and not only in the older group.

Table 3 presents the hazard ratios for occupational physical demands and the risk of musculoskeletal claims for younger (<25), middle-aged (25–44) and older (45 and older) workers. The relationship between occupational demands and risk of musculoskeletal claims was strongest in the middle-aged workers, attenuating slightly in the oldest age group and lowest in the youngest age group.

### Discussion

Our findings supported the hypothesis that older age and greater occupational demands were associated with an increased risk of claims for serious musculoskeletal injury. The relationship between age and claim-risk was strongest when occupational demands were highest. However, we observed a difference in this relationship across all age groups, not just among older workers. We further observed that the relationship between occupational demands and musculoskeletal claim-risk was strongest among workers aged 25–44. Although occupational demands were still associated with an increased claim-risk among the oldest age group (45 and older), this relationship was weaker (and statistically different) to that observed in the 25–44 age group. This suggests that although occupations with higher demands and older workers should be the targets of primary preventive efforts related to musculoskeletal injuries, there may be gains in targeting middle-aged workers in the most physically demanding occupations as differences in occupational demands appear to have a greater impact in this group.

Our results should, however, be interpreted in light of the following limitations. Our study relied on workers’ compensation records and workers’ compensation claims probably do not include all work-related injuries [24]. These differences may be exacerbated in systems such as Victoria, where reporting thresholds are in place. However, at the population level, workers’ compensation claims may identify musculoskeletal conditions more effectively than alternatives such as emergency department databases [25]. There may also be variations in the actual tasks performed within occupational classification categories. For example, it is possible that workers with greater seniority (job tenure) may not have to undertake the more physically demanding tasks [26] or may perform them for less time during the working day than workers with less seniority. Given that seniority is likely to be associated with age (older workers having greater seniority), this may have led to a smaller risk among older workers in more demanding occupations, biasing our interaction effects to the null. Finally, we were limited in our ability to adjust our estimates for age and occupation beyond gender and year of injury. Ideally, we would have also included other factors such as job tenure [12] and workplace size [27] in our models. However, this was not possible in our analyses due both to the unavailability of this information, and to the small cell sizes already present in our denominator estimates for some groups, such as older women working in physically demanding occupations.
Our finding that the relationship between occupational demands and risk of injury differed across age groups is consistent with a previous French study using self-reported information [13]. However, in our study, the relationship between occupational demands and risk of injury was highest among middle-aged workers, whereas in the previous French study, it was highest in the oldest age group. These differences could be due to differences in the types of injuries considered in these two studies. Our study relied on workers’ compensation claims submitted after 10 days’ absence from work, or health care expenditure above a threshold, whereas the French study relied on self-reported injuries resulting in at least 1 day of absence (not including the day of injury) with a 24 month recall period. In addition, we restricted our sample of injuries to musculoskeletal conditions only because we expected occupational physical demands to be most strongly related to these types of work-related conditions.

The lower risk of injury associated with physical occupational demands among the oldest age group could be due both to the healthy worker effect (where only the healthiest workers remain in the most physically demanding occupations [28]) and to the healthy hiring effect (where only the healthiest workers are hired into occupations with the highest physical demands [29]). This finding is supported by other studies, which have found the need for recovery after work to be highest among middle-aged workers and to decline among workers aged 46–55 [30].

In conclusion, we observed an interaction in the effects of age and physical occupational demands on the risk of serious work injury in the state of Victoria, Australia. Although older age and greater physical demands were associated with an increased risk of serious injury, the relationship between age and risk of serious work injury was steeper when occupational demands were greater. Similarly, the relationship between occupational demands and risk of injury differed across age group, being most pronounced among middle-aged workers. These findings suggest that primary prevention activities targeting serious musculoskeletal injuries should focus on both age and occupational demands, as well as on the interplay between these two factors.

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**Conflicts of interest**

None declared.

**References**


**Key points**

- In this study, the relationship between age and risk of musculoskeletal injury claims differed depending upon physical work demands.
- Differences in injury claim risk across differing levels of physical work demands were least among younger workers, followed by older workers and greatest among middle-aged workers.
- Prevention efforts targeting serious musculoskeletal conditions should consider age and occupational demands in their design.


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