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What can musicians' claims data reveal about their musculoskeletal conditions?
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WHAT CAN MUSICIANS' CLAIMS DATA REVEAL ABOUT THEIR MUSCULOSKELETAL CONDITIONS?

Abstract

Musculoskeletal (MSK) symptoms are common amongst professional musicians. No study has reported on workers' compensation claims (WCCs) of musicians to determine the proportion of claims and costs attributed to MSK conditions. We analysed Australian WCCs for professional musicians 2004/2005-2015/2016. MSK conditions accounted for 69.78% of claims; 50.46% of which were for upper limb conditions. MSK conditions also accounted for 77.76% of costs for musicians' WCC. The most common reported mechanism for MSK claims was body stressing (72.48%), and the most common agency "other non-powered equipment" (including musical instruments; 39.71%), which also accounted for 51.27% of upper limb claims specifically. For the first time, we showed that MSK conditions account for the majority of musicians' WCC, and the majority of the cost of claims, making them the biggest health issue for professional musicians.

Keywords: musicians, musculoskeletal, injury, compensation, burden, cost

Introduction

Musculoskeletal (MSK) disorders are the third leading cause of years lived with disability globally.[1] When considering specific conditions, low back pain is the leading cause of years lived with disability, with neck pain and other musculoskeletal disorders also ranking in the top 10, both globally and in Australia.[1] In Australia, work-related MSK conditions (including fractures, joint, ligament and muscle injury, and MSK disorders) accounted for 42% of the estimated $61.8 billion total cost of occupational illness and injury during the 2012-2013 financial year.[2] Musculoskeletal conditions also accounted for 61.94% of workers' compensation claims (WCC) from 2009-2014,[3] and are also a priority area for prevention under the *Australian Work Health and Safety Strategy 2012-2022*.[4]

Musculoskeletal symptoms are common amongst musicians[5-9], particularly professionals[9], with MSK symptoms leading to participation restrictions and activity limitations.[10-12] For some musicians, MSK symptoms have led to them stopping playing[13], or changing careers.[14,15] Notwithstanding the impact of symptoms for individual musicians, the viability of Australia's orchestras has previously been threatened by the high cost of workers' compensation insurance, which increased from A$ 0.75 million to A$ 1.7 million over a three year period (2001-2004).[16] The insurance premiums equated to 2.5% of the cost of wages and salaries in the 2003/2004 financial year, and as high as 4.8% for one orchestra.[16] These findings highlight the importance of WCC to the financial viability of musical ensembles.

While there is a large body of recent evidence regarding MSK symptoms in musicians[17], and some evidence for compensation claiming behaviour[11], no published study, to our knowledge, has analysed WCC data for musicians MSK conditions. Analysis of WCC data provides an opportunity to fill a number of gaps in the current evidence base; in particular: 1) whether musicians' MSK conditions are the leading compensable health problem for musicians on a numerical basis; 2) whether MSK conditions are the most costly condition and result in the

most time off from work for musicians; and 3) the nature, location, mechanism and agency of MSK conditions claimed for. This information will potentially provide a foundation for future work aimed at reducing the health burden for musicians, and improving the financial viability of their employers.

Materials and Methods

Individual level data from Safe Work Australia's National Data-Set 3 (National Data Set for Compensation-based Statistics, third edition; NDS-3)[18] were obtained for musicians (Australian and New Zealand Standard Classification of Occupations (ANZSCO)[19] unit group 2112), for the financial years (1 July – 30 June) 2004/2005-2015/2016. Music professionals (ANZSCO unit group 2112) included instrumentalists, singers, music directors and composers.[19] Music teachers were not included within the present study as they were classified as 'private tutors and teachers', along with other types of private tutors, including art, dance and drama[19], such that music teacher specific data were not available.

Variables obtained from the NDS-3 were age, gender, the month and year of the reported incident, the financial year the claim was lodged, and the nature, body region, agency, and mechanism of the condition, as well as the time lost and claim costs (see NDS-3[20] for further details of the variables). Data regarding the type of musician (e.g. opera, orchestral) were not available. Classification of the injury/disease were taken from the Type of Occurrence Classification System, Third Edition (TOOCS3)[21], which is based upon the International Classification of Diseases and Related Health Problems, 10th Revision, Australian modification, with aggregated classifications.[20] For the purpose of this study, we classified fractures and traumatic joint/ ligament and muscle/ tendon injury categories as MSK injuries, and MSK and connective tissue diseases as MSK diseases.

Data were largely reported descriptively, and based on the number of claims. We did not investigate the incidence of WCC for musicians, as no valid denominator was available. Although the 2011 Census of Population and Housing[22] reported that there were 7 960 professional musicians in Australia, this number includes Defence and self-employed musicians, who are not eligible for workers' compensation. Furthermore, in the Census, individuals are asked to report only the job in which they usually worked the most hours[22], however, on average, professional musicians only work 19 hours per week as a musician, with a further 26 hours per week on average devoted to non-musical work.[23] In addition, 86% of Australian professional musicians worked in a freelance or self-employed capacity in 2016[23], up from 67% in 2009.[24] As such, the Census data[22], cannot be used to estimate the number of people employed as musicians in Australia, who were eligible for workers' compensation, nor the average number of hours working in an employed capacity.

Ethics approval for the analysis of national WCC data was granted by the University of Adelaide Human Research Ethics Committee (HREC-2015-279).

Results

From the 2004/2005 to 2015/2016 financial years, 781 claims for workers' compensation were made by musicians in Australia. Of the claimants, 43.66% were female, and the mean age of claimants was 51.8±11.7 years. A total of 545 (69.78%) claims were made for MSK conditions (Table 1). The demographics of musicians who claimed for MSK conditions were similar to those of all claims (mean age 52.1±11.4 years, 46.42% female).

Musculoskeletal claims

Of the MSK claims, 60.37% were for injuries, rather than diseases. The most common types of MSK conditions claimed for were diseases of muscle, tendon and related tissue (15.23%), trauma to joints/ ligaments (10.09%), trauma to muscles/ tendons (20.73%) and residual soft

tissue disorders due to trauma or unknown mechanisms (23.12%; Table 2). Specific diagnoses are reported in the Appendix.

Table 1: Percentage of claims due to each condition type

Injuries	***58.00%***
Traumatic joint/ ligament and muscle/ tendon injury[a]	37.64%
Fractures[a]	4.48%
Wounds, lacerations, amputations and internal organ damage	10.12%
Other injuries	5.76%
Diseases	***41.23%***
Musculoskeletal and connective tissue diseases[a]	27.66%
Nervous system and sense organ diseases	4.48%
Mental diseases	3.84%
Other diseases	5.25%
Other claims	***0.77%***

Note: [a]indicates classified as a musculoskeletal condition

Table 2: Percentage of musculoskeletal claims for each musculoskeletal condition

Musculoskeletal diseases	***39.63%***
Diseases of muscle, tendon and related tissue	15.23%
Spinal vertebrae and intervertebral disc diseases - dorsopathies	8.62%
Diseases involving the synovium and related tissue	3.30%
Joint diseases (arthropathies) and other articular cartilage diseases	2.02%
Other soft tissue diseases	7.16%
Other musculoskeletal and connective tissue diseases (not classified elsewhere)	3.30%
Musculoskeletal injuries	***60.37%***
Residual soft tissue disorders due to trauma or unknown mechanisms	23.12%
Trauma to muscles/ tendons	20.73%
Trauma to joints/ ligaments	10.09%
Fractures	6.42%

From the 2004/2005 to 2015/2016 financial years, there was a decrease in the number of claims overall made by musicians, including for MSK conditions specifically (Figure 1). For MSK claims, 84.95% of claims occurred within the same financial year as the incident, with a further 13.03% of claims being made in the financial year following the incident. Six claims occurred two years after the incident; three were three years later, and one each for 10 and 16 years after the incident.

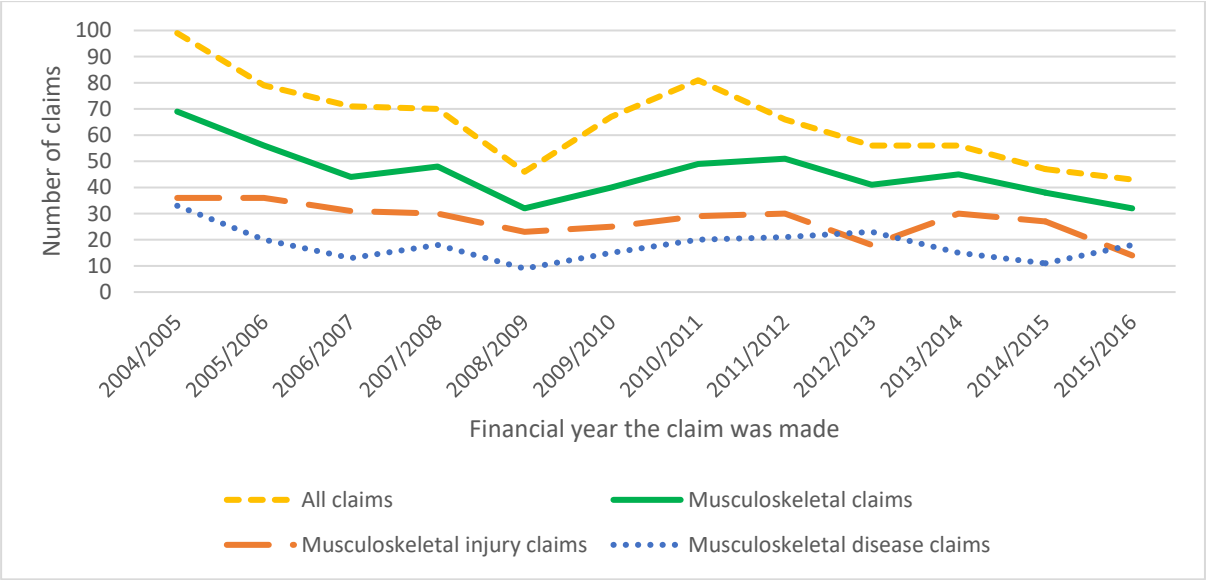

Figure 1: Number of claims per financial year.
Note: 2015/2016 data were provisional

There were fewer MSK condition claims made for incidents occurring in the months of January and December, as well as a drop in MSK injury claim incidents in January, July and December. For MSK disease claims, there were fewer incidents in January, June and December (Figure 2).

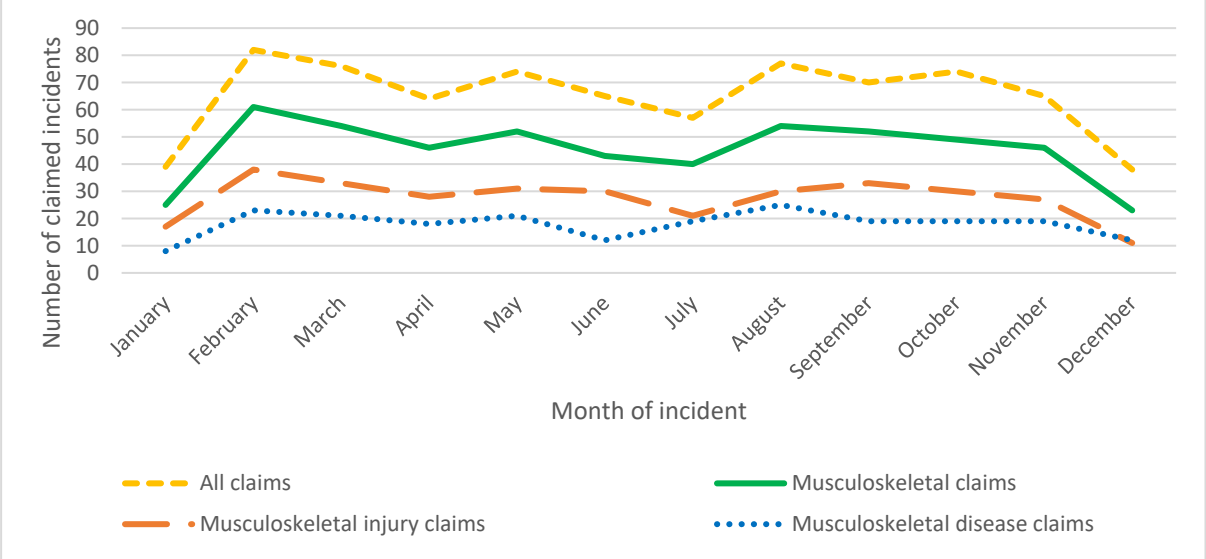

Figure 2: Number of claims per month

Body regions

The most commonly affected body region for MSK conditions was the upper limb, representing 50.46% of all MSK condition claims (Table 3). The upper limb was also the most commonly affected body region for both MSK injuries and diseases specifically, and was the only broad body region for which the disease claims outnumbered injury claims. Within the upper limb region, the shoulder region was the most commonly affected area representing 16.88% of all MSK claims, while the hand/ finger/ thumb region was affected for 11.74% of MSK claims.

Table 3: Proportion of musculoskeletal claims by body region

	All musculoskeletal claims	Musculoskeletal disease claims	Musculoskeletal injury claims
Upper limbs	50.46%	65.75%	40.43%
Lower limb	14.50%	5.56%	20.36%
Trunk	13.76%	13.43%	13.98%
Neck	9.36%	10.65%	8.51%
Head	1.65%	0.46%	2.43%
Multiple	10.28%	4.17%	14.29%

Notes: Multiple areas referred to 'neck and trunk' (n=11), 'trunk and limbs' (n=9), 'upper and lower limbs' (n=4), 'neck and shoulder' (n=14), 'other specified multiple locations' (n=15), and 'unspecified multiple locations' (n=3)

With the exception of the drop in the number of claims in the 2008/2009 financial year for the upper limb, there has been little change in the number of MSK claims by body region during the 12-year study period (Figure 3). Figure 4 reports the number of claimed incidents per month, indicating that January and December have the lowest number of claimed MSK incidents, across all body regions.

Mechanism and agency

Body stressing was the reported mechanism for 72.48% of MSK conditions, and was also the mechanism for the majority of MSK injuries (62.31%) and diseases (87.96%) specifically. Body stressing was also the most commonly reported mechanism for MSK conditions in all body regions, with the exception of the lower limb (Table 4). Body stressing still accounted for 37.97% of lower limb MSK claims, however falls, trips and slips of a person were more commonly reported (46.84%).

Of the types of body stressing, muscular stress while handling objects accounted for at least 30% of MSK claims in each body region, with the exception of the lower limb where only 3.80% of

claims were attributed to handling objects (Table 4). For lower limb MSK conditions, 25.32% were attributed to muscular stress with no objects, while 29.41% of neck and 29.82% of upper limb MSK claims were attributed to repetitive movement with low muscle loading.

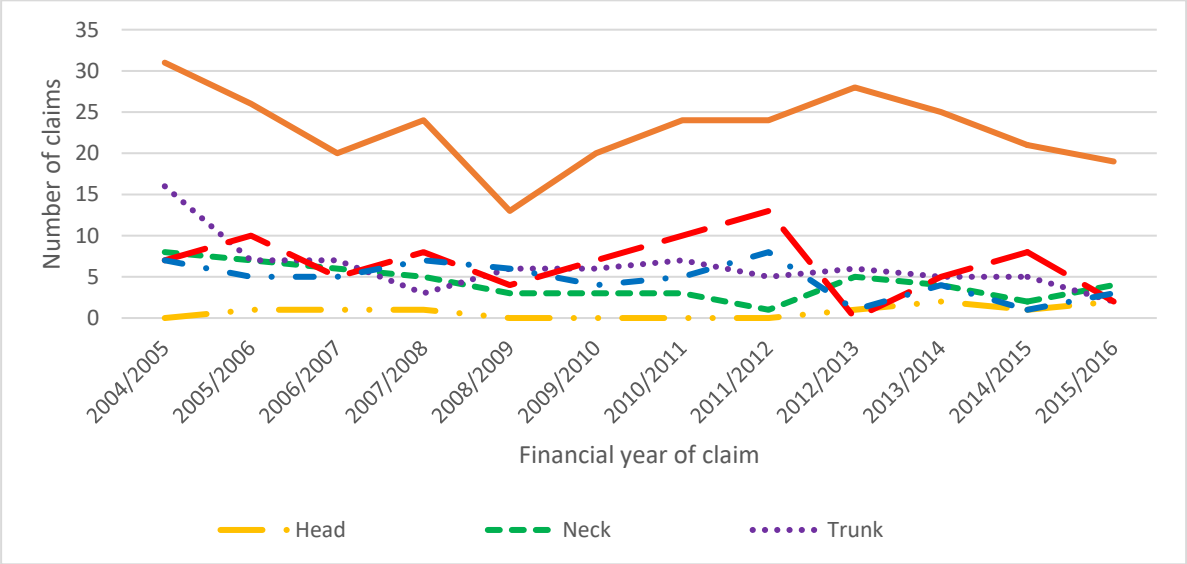

Figure 3: Number of musculoskeletal claims per financial year by body region
Note: the 2015/2016 data were provisional

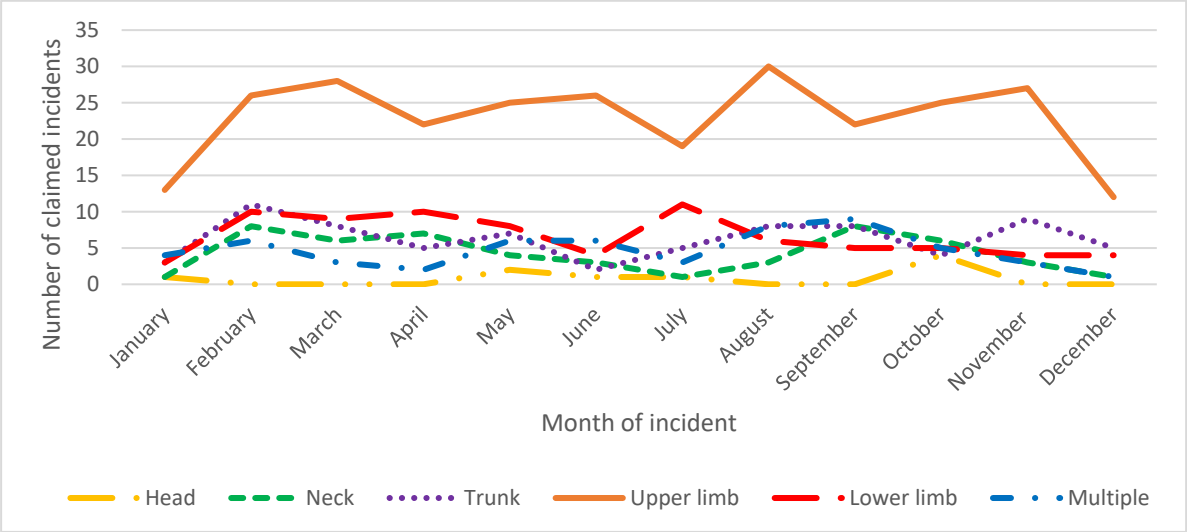

Figure 4: Number of incidents per month, by body region

The main type of agency leading to any type of MSK condition claim was non-powered hand tools (which includes musical instruments). Non-powered hand tools accounted for 48.16% of

MSK claims, and was the leading agency for both MSK injuries (44.21%) and diseases (54.17%). Similarly, non-powered hand tools were the most common reported agency across all body regions, except the lower limb where environmental agencies led to 46.84% of lower limb MSK claims.

Within the non-powered hand tools category there is no specific category for musical instruments, but these fit within the "other non-powered equipment" category. "Other non-powered equipment" led to 39.71% of all MSK conditions, 35.98% of MSK injuries and 45.37% of MSK diseases (Table 6). "Other non-powered equipment" was reported as the agency for 51.27% of upper limb MSK claims, and for over 25% of claims in other body regions, except the lower limb (6.33%).

Table 4: Percentage of musculoskeletal claims attributed to each mechanism, by nature and body region

	All musculoskeletal	Injury	Disease	Head	Neck	Trunk	Upper limb	Lower limb	Mulple locations
Body stressing	***72.48***	***62.31***	***87.96***	***44.44***	***84.31***	***81.33***	***81.82***	***37.97***	***57.14***
Muscular stress while lifting, carrying, or putting down objects	8.62	8.51	8.80	0.00	7.84	25.33	6.55	3.80	5.36
Muscular stress while handling objects	33.58	26.75	43.98	33.33	37.25	37.33	40.00	3.80	35.71
Muscular stress with no objects being handled	10.64	12.77	7.41	0.00	9.80	14.67	5.45	25.32	12.50
Repetitive movement, low muscle loading	19.63	14.29	27.78	11.11	29.41	4.00	29.82	5.06	3.57
Falls, trips and slips of a person	***15.05***	***20.97***	***6.02***	***22.22***	***1.96***	***8.00***	***9.09***	***46.84***	***19.64***
Falls from a height	4.77	6.99	1.39	0.00	0.00	2.67	2.18	18.99	5.36
Falls on the same level	8.62	12.46	2.78	22.22	1.96	4.00	6.18	21.52	12.50
Stepping, kneeling or sitting on an object	1.47	1.22	1.85	0.00	0.00	1.33	0.73	6.33	0.00
Being hit by moving objects	***3.85***	***5.47***	***1.39***	***22.22***	***0.00***	***1.33***	***3.27***	***7.59***	***5.36***
Being hit by falling objects	0.92	1.52	0.00	0.00	0.00	0.00	0.73	2.53	1.79
Being hit by a person accidentally	1.47	1.82	0.93	11.11	0.00	1.33	1.09	3.80	0.00
Being trapped between stationary and moving objects	0.37	0.61	0.00	0.00	0.00	0.00	0.73	0.00	0.00
Being hit by moving objects	0.73	0.91	0.46	0.00	0.00	0.00	0.36	1.27	3.57
Being assaulted by a person or persons	0.37	0.61	0.00	11.11	0.00	0.00	0.36	0.00	0.00
Hitting objects with a part of the body	***0.92***	***0.91***	***0.93***	***0.00***	***0.00***	***1.45***	***1.27***	***0.00***	***5.36***
Hitting stationary objects	0.37	0.61	0.00	0.00	0.00	0.00	0.36	1.27	0.00
Hitting moving objects	0.55	0.30	0.93	0.00	0.00	0.00	1.09	0.00	0.00
Other and unspecified	***7.71***	***10.33***	***3.70***	***11.11***	***13.73***	***9.33***	***4.36***	***6.33***	***17.86***
Vehicle incident	3.85	6.38	0.00	0.00	9.80	2.67	0.73	5.06	14.29
Other and multiple mechanisms of incident	1.10	0.91	1.39	11.11	0.00	1.33	1.09	0.00	1.79
Unspecified mechanisms of incident	2.75	3.04	2.31	0.00	3.92	5.33	2.55	1.27	1.79

Table 5: Percentage of musculoskeletal claims attributed to each type of agency, by nature and body region

	All musculoskeletal	Injury	Disease	Head	Neck	Trunk	Upper limb	Lower limb	Multiple body regions
Machinery and (mainly) fixed plant	0.18	0.30	0.00	0.00	0.00	1.33	0.00	0.00	0.00
Mobile plant and transport	4.41	7.32	0.00	0.00	9.80	4.00	0.73	5.06	18.18
Powered equipment, tools and appliances	3.86	2.13	6.48	0.00	5.88	4.00	4.36	2.53	1.82
Non-powered hand tools, appliances and equipment	48.16	44.21	54.17	55.56	56.86	44.00	58.91	12.66	41.82
"Other non-powered equipment" (includes instruments)	*39.71*	*35.98*	*45.37*	*55.56*	*49.02*	*26.67*	*51.27*	*6.33*	*36.36*
Materials and substances	9.01	4.27	16.20	0.00	7.84	16.00	9.09	6.33	5.45
Environmental agencies	13.05	19.82	2.78	33.33	1.96	6.67	6.91	46.84	10.91
Animal, human and biological agencies	2.76	3.35	1.85	11.11	1.96	2.67	1.45	3.80	7.27
Other and unspecified agencies	18.57	18.60	18.52	0.00	15.69	21.33	18.55	22.78	14.55

"Other non-powered equipment" (which includes musical instruments) accounted for 52.85% of body stressing claims. For falls, trips and slips the most commonly reported agency was environmental (74.07%), hitting objects was most commonly related to non-powered hand tools (60.00%), being hit to animal, human and biological (38.10%), and other and unspecified mechanisms to mobile plant and transport (48.84%; Table 6).

Table 6: Percentage of each mechanism type related to each agency type for musculoskeletal claims

	Falls, trips and slips	Hitting objects	Being hit	Body stressing	Other & unspecified
Machinery and (mainly) fixed plant	0.00	0.00	0.00	0.25	0.00
Mobile plant and transport	0.00	0.00	9.52	0.25	48.84
Powered equipment, tools and appliances	0.00	40.00	0.00	4.71	0.00
Non-powered hand tools, appliances and equipment	18.52	60.00	28.57	60.05	2.33
"Other non-powered equipment" (includes instruments)	*3.70*	*20.00*	*14.29*	*52.85*	*2.33*
Materials and substances	3.70	0.00	9.52	11.17	0.00
Environmental agencies	74.07	0.00	4.76	2.23	2.33
Animal, human and biological agencies	2.47	0.00	38.10	0.99	2.33
Other and unspecified agencies	1.23	0.00	9.52	20.35	44.19

Time off and costs of claims

The median time off from work for all claims was seven hours, while for MSK conditions it was 10.0 hours (Table 7). Musculoskeletal injuries resulted in a median of 7.6 hours off from work, whereas muscuoskeletal diseases resulted in 24.0 hours off from work. The body regions with the longest time lost were the upper limb (median 38.0 hours) and neck (median 30.0 hours) (Table 7).

Table 7: The median time lost and cost for claims by condition type

	Time lost in hours (median, IQR)	Cost (AUD) of a claim (median, IQR)
All claims	7.0 (0.0-152.0)	2 104 (427-10 578)
Musculoskeletal conditions	10.0 (0.0-160.0)	2 520 (574-12 325)
Non-musculoskeletal conditions	0.0 (0.0-152.0)	1 242 (0-5 524)
Nature of musculoskeletal condition		
Injury	7.6 (0.0-153.6)	2 426 (699-10 652)
Disease	24.0 (0.0-176.6)	2701 (255-14 634)
Location of the musculoskeletal condition		
Head	0.0 (0.0-288.5)	4 148 (1 209-31 547)
Neck	30.0 (0.0-187.0)	1 355 (378-14 482)
Trunk	0.0 (0.0-40.0)	1 015 (130-3 711)
Upper limb	38.0 (0.0-208.0)	4 981 (1 071-16 389)
Lower limb	0.0 (0.0-57.6)	1 263 (288-5 658)
Multiple	7.0 (0.0-126.4)	1 739 (689-12 260)

Note: IQR: Interquartile range

Musicians' WCC cost a total of A$9 291 470 from 2004/2005 to 2015/2016. Musculoskeletal conditions accounted for A$7 224 999 (77.76%) of the total cost of claims, with 57.56% of the MSK condition cost being attributed to injuries. The total cost of upper limb MSK conditions was A$ 4 633 785, accounting for 49.87% of the cost of all claims, and 64.14% of all MSK claims.

The median total cost per MSK claim was A$2 520, whereas the median total cost per non-MSK claim was A$1 242 (Table 8). With the exception of common law benefits (which were only seen in non-MSK condition claims), MSK condition claims accounted for the majority of costs in each category (Figure 5). The highest treatment costs for MSK conditions were for medical services, followed by allied health services (Figure 5).

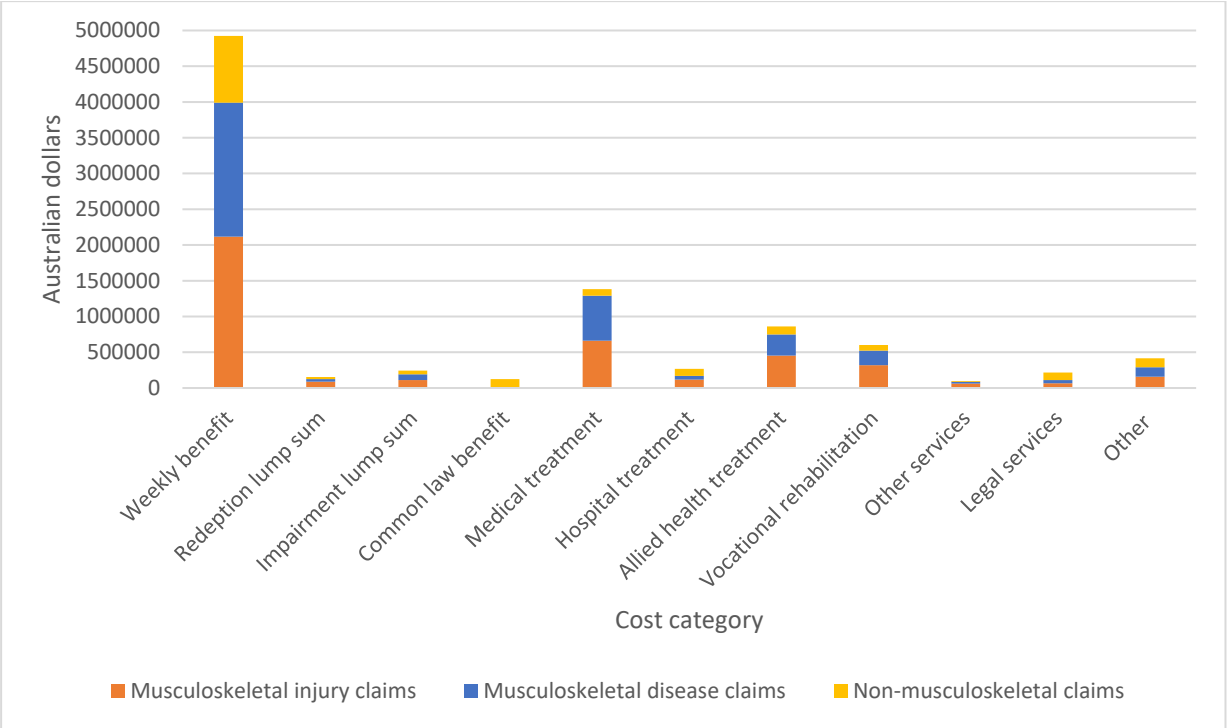

Figure 5: Costs of claims

Discussion

The present study was the first to review MSK WCC for a population of musicians, with the overall aim of determining whether MSK conditions were the biggest compensable health problem for professional musicians, and also the profile of claimed conditions. Musculoskeletal conditions were found to be the biggest health problem for professional musicians, accounting for 69.78% of WCCs, which appears to be slightly higher than that of the general working population (61.94%).[3] For musicians, the high proportion of MSK condition claims, and the finding that 77.76% of the cost of musicians' WCC were attributed to MSK conditions, highlights the importance of addressing MSK conditions for musicians.

Of the MSK condition claims, 60.37% were for injuries, rather than diseases, which is in contrast with previous suggestions that most musicians' MSK conditions have a gradual onset (i.e. diseases).[25] Potential reasons for this discrepancy include the symptom severity, and claiming behaviour. It is possible that the symptoms following an injury are more severe and therefore require time off, when compared with diseases. Musculoskeletal injuries (traumatic)

may also be easier to justify as legitimate conditions as they may have more visible signs, when compared with diseases (atraumatic)[26], with musicians reporting difficulties in proving the existance of symptoms.[27] Injuries may also be easier to report owing to having a 'incident' where the date and location can easily be reported, in comparison with the chronic exposure leading to diseases which may include a combination of work-related and non-work-related activities.[11] As a result, a higher proportion of those with MSK injuries may claim and receive compensation, when compared with MSK diseases.

Under-reporting

Owing to the previously described lack of a valid denominator we were unable to determine the incidence of MSK conditions among musicians. Chimenti et al.[11] recently suggested that orchestral musicians under-report MSK symptoms to compensation bodies. In their cross-sectional survey only, 3.4% of orchestral musicians had claimed workers' compensation for playing-related symptoms during their careers.[11] Chimenti et al.[11] did not report the career prevalence of playing-related symptoms, however the 12 month prevalence was 93%; hence a small minority of orchestral musicians with playing-related symptoms claimed compensation. Importantly, 58.2% of orchestral musicians in Chimenti et al.'s[11] study reported that they did not claim compensation as the injury was not bad enough to require time off, with a further 6.1% indicating that they did no do so because there was too much paperwork. This is similar to the Australian workforce, wherein 57.89% of those who experienced a work-related injury but did not claim compensation stated that they had not claimed because the injury was minor and reporting it was too much effort.[28] Chimenti et al.[11] also reported that 10.0% of musicians who did not claim workers' compensation chose not to do so for fear of demotion, and with a further 11.1% indicating that they did not want their co-workers to be aware of their injury. The fear of a claim having a negative impact on employment is not restricted to musicians, with 5.26% of Australian workers' who experienced a work-related injury not claiming compensation

because of the negative impact it may have on their employment.[28] While the WCCs data may represent the minority of MSK conditions, they arguably report the most serious MSK conditions, and therefore those that require the most attention to reduce the burden of MSK conditions for musicians.

Upper limb conditions

Upper limb MSK conditions accounted for 50.46% of all MSK conditions, with the shoulder accounting for 16.88% of all MSK claims, and the hand/ finger/ thumb region for 11.74% of claims. Upper limb MSK diseases accounted for 65.74% of MSK diseases, while upper limb MSK accounted for 40.43% of all MSK injuries. Similarly, upper limb MSK conditions were the most costly MSK conditions, accounting for 64.14% of the total cost of MSK claims. A recent cross-sectional study[29] of Australian professional orchestral musicians, also found that the lifetime prevalence of pain or injury was highest in the upper limb. Upper limb MSK conditions, therefore warrant the most attention when investigating and intervening for musicians' MSK conditions.

Mechanism and agency

Body stressing was the most commonly reported mechanism for causing MSK conditions (72.48%); both for diseases (87.96%) and injuries (62.31%). The most commonly reported type of body stressing was muscular stress while handling objects, with repetitive movement with low muscle loading also being common for upper limb MSK conditions. These findings are to be expected given the repetitive finger movements required for playing many musical instruments, as well as the sustained postures required to play many instruments, often having to support the instrument against gravity. This hypothesis is further supported by the finding that 51.27% of upper limb MSK claims, and 39.41% of all MSK claims had "other non-powered equipment" as the agency. Based on these findings, addressing repetitive movement and

handling objects, especially musical instruments, would be expected to reduce the burden of MSK conditions in musicians.

Temporal trends

While there is some evidence of a decrease in all musicians' WCC, as well as MSK claims specifically from 2004/2005 to 2015/2016, much of the reduction for MSK claims occurred prior to the 2006/2007 financial year. This may be due to changes in reporting behaviour, following the 2005 inquiry into the viability of Australia's eight main symphony orchestras.[16] As data regarding the type of musician (e.g. orchestral, opera) were not available, we are unable to determine whether the drop in claims from 2004/2005-2006/2007 was predominantly seen in orchestral musicians. We estimate, based on the number of musicians employed by the orchestras[30], the Census data[22] and the estimate that only 14% of musicians are in ongoing employment[23], that the majority of musicians eligible for workers' compensation in Australia are employed by the eight main orchestras. As such, changes in the reporting behaviour of orchestral musicians in Australia would be expected to influence the overall trends in musicians' claims. With the exception of a notable trough in the number of claims in the 2008/2009 financial year, there was little difference in the number of claims from 2006/2007 to 2014/2015 (with the 2015/2016 data being provisional at the time of the study). This finding is in spite of many interventions being introduced into Australian orchestras[30,31], in response to Strong's[16] 2005 report; however we are unable to ascertain whether there were any reductions in claim numbers for orchestral musicians specifically. Importantly it is also not possible to determine whether there the interventions had led to a change in reporting behaviour (e.g. reductions in stigma, encouraging reporting). Owing to the lack of a valid denominator we were unable to determine whether the incidence of MSD WCCs changed over the study period. There was little change in the number of professional musicians in Australia from 2006 to 2011[22], but an increase in the proportion of professional musicians working in a freelance or self-employed

capacity from 2009 to 2016[23,24]; which may indicate an increase in the incidence of musicians' WCC over the study period.

The trough in the number of claims during the 2008/2009 financial year aligns with the Global Financial Crisis (GFC), which commenced in the latter half of 2008.[32] The GFC may have influenced the number of claims due to a potential reduction in the size of the musician workforce at this time, a reduction in the hours worked by musicians, or a change in claiming behaviour. Musicians' employment is precarious, and reliant on having paying audiences. The GFC may have reduced the disposable income within the general population and was therefore likely to have influenced the number of employed musicians and/or the number of hours worked because of reduced audiences. The instability of musical employment, particularly at this time, may have also led to a greater reluctance to claim workers' compensation, which may in turn have altered their perceived job stability and future opportunities. The potential change in reporting behaviour in the 2008/2009 financial year may have been exaggerated by the 2005 report into the viability of the orchestras.[16]

Internationally, there was a sharp decline in MSK disorder claims for the general working population at the time of the GFC, however this was found not to relate to changes in the size of the workforce, nor the number of hours worked.[33,34] The authors of that study[33,34] suggested that the decline may therefore have been due to changes in claiming behaviour owing to the instability in employment at the time. In Australia, there was no such decrease in the number nor incidence of any WCC for the general workforce[3], however for MSK conditions specifically, where time was lost, there was a modest decline in the incidence of MSK conditions, particularly for males aged <55 years.[35] In Canada, the declines in the incidence of MSK conditions, where time was lost, for males were steeper than in Australia, with more modest declines also evident for females aged <55 years.[35] Unlike the temporal changes for musicians, WCC incidence continued to decline[35], rather than having a sharp increase from 2008/2009 to

2009/2010 as was the case for musicians. For musicians, the potential changes in the size of the workforce, and perceived job stability during the GFC, may have led to the trough in the number of claims during the 2008/2009 financial year. As data on the musical population size, and hours worked, were not available for this time period we were unable to test this hypothesis beyond speculation.

Variation throughout the year

There was variation in the number of claims across the year, with the lowest number both for all claims, and MSK claims (including serious claims, injuries and diseases) occurring in December and January. There was also some evidence of a decline in claims in April, and September. A clearer reduction was evident in July, with the exception of MSK disease claims which were lower in June and increased in July. We suspect that these differences may relate to fewer musicians working during these months, or to a reduction in total work hours. The months where there were fewer claims align with school holidays in Australia. While we did not include claims for music teachers, performing musicians often engage in teaching; hence these months may reflect times when they are working less in total. The decline in MSK disease claims in June, which did not fit the overall pattern, may reflect a temporal change in claiming behaviour. As diseases are more ongoing in nature than injuries, it may be that musicians are less inclined to claim for musculoskeletal diseases when they know they will have a quieter workload in the coming weeks. We recommend that future research consider changes in the occurrence of MSK symptoms, and MSK claims, with particular reference to changes in the musician population size and number of hours worked, to further explore these temporal associations.

Future directions

One of the limitations of using WCCs data is that some workers are not eligible for compensation. This is particularly true of Australian musicians, where 86% are either freelance

or self-employed[23], and many musicians are employed by the Australian Defence Force making them ineligible for workers' compensation. The Australian Bureau of Statistics'[36] Work-Related Injuries survey provides another strategy to explore work-related injuries and illness, however data are not available for musicians specifically.

To overcome some of the issues with WCCs, data should be triangulated with other sources of information, such as surveys and/or industry specific surveillance. While surveillance programs have been trialled with orchestral musicians, these were unsuccessful owing to low participation.[30] Although a new surveillance program was due to be trialled in 2014[30], the results of this trial are yet to be published. Triangulating data from multiple data sources may assist in overcoming some of the limitations of each of these approaches, such as the lack of a valid denominator, self-selection bias, reporting bias, and healthy worker effect, leading to more valid conclusions, from which effective recommendations to reduce to burden of MSK conditions for musicians can be proposed.

The findings of the present study suggest that playing a musical instrument, both in terms of repetitive movements and handling an object, may be related to claimed MSK conditions. The limitation of these data are that only one agency and mechanism can be reported, however MSK conditions are likely multifactorial. As such, a more detailed examination of the factors leading to MSK symptoms, particularly in the upper limbs, is required. Ultimately, addressing these factors should lead to a reduction in the burden of MSK conditions for musicians.

The findings of this study suggest that existing work health and safety policies and practices for employers of musicians do not adequately address the main health problem for musicians – MSK conditions. Improving policies and practices around body stressing in particular would be expected to lead to the greatest reductions in the burden of musicians' MSK conditions. One of the challenges for organisations who employ musicians is that there is currently insufficient

evidence to draw strong conclusions regarding the associations between potential risk factors and MSK outcomes.[37] Similarly, a recent systematic mapping review[17] identified only four recent studies[38-41] that had investigated the effectiveness of public health interventions for professional musicians. These interventions were exercise programs for orchestral musicians[39-41], and new footwear for military band musicians.[38] New footwear did not result in changes in the incidence of injury,[38] while the evidence for exercise programs was mixed[39-41], with positive outcomes relating only to pre-post analyses.[40,41] In order to develop evidence-based recommendations for policy and practice changes for musical employers, research should be directed towards investigating the association between modifiable factors, particularly organisational factors, and MSK outcomes. Knowledge of the risk factors for MSK outcomes can then be used to develop interventions. If the interventions are found to be safe and effective they should then be incorporated into work health and safety policies and practices for the music industry, to reduce the burden of MSK conditions for professional musicians.

Conclusion

Musculoskeletal conditions are the most important health problem for professional musicians, accounting for 69.78% of claims, and 77.76% of the cost of workers' compensation claims, indicating that in order to reduce the burden of health issues among professional musicians in Australia, research into and interventions addressing MSK conditions are paramount. As the upper limb MSK conditions account for 50.46% of MSK claims, and 64.14% of the cost of MSK claims, the focus should be on upper limb MSK conditions, in order to address the burden of MSK conditions for musicians.

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Appendix: Diagnoses

	Injury	Disease
Mouth	Fractured skull and facial bones (n=2) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=1)	
Nose	Fractured skull and facial bones (n=1) Other fractures, nec (n=1)	
Face - nec	Fractured skull and facial bones (n=1) Trauma to muscles (n=1) Trauma to muscles and tendons, nec (n=1)	Joint and other articular cartilage diseases, nec (n=1)
Neck	Other fractures, nec (n=1) Trauma to joints and ligaments, nec (n=3) Trauma to muscles (n=2) Trauma to muscles and tendons, nec (n=1) Trauma to muscles and tendons, unspecified (n=5) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=16)	Disc displacement, prolapse or herniation (n=4) Neck pain, cervicalgia (n=10) Spinal vertebrae and intervertebral disc diseases nec (n=1) Spinal vertebrae and intervertebral disc diseases , unspecified (n=2) Muscle/ tendon strain (non-traumatic) (n=3) Occupational overuse syndrome (n=2) Soft tissue diseases due to non-traumatic causes with insufficient information to code as 'other soft tissue disease' or 'diseases involving the synovium and related tissue' (n=1)
Back – upper or lower	Fracture of vertebral column without mention of spinal cord lesion (n=1) Trauma to joints and ligaments, nec (n=2) Trauma to joints and ligaments, unspecified (n=3) Trauma to muscles (n=5) Trauma to tendon (n=1) Trauma to muscles and tendons, nec (n=2) Trauma to muscles and tendons, unspecified (n=9) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=19)	Disc displacement, prolapse or herniation (n=3) Back pain, lumbago, and sciatica (n=24) Spinal vertebrae and intervertebral disc diseases, unspecified(n=1) Muscle/ tendon strain (non-traumatic) (n=1)
Chest (thorax)	Other fractures, nec (n=1) Trauma to muscles and tendons, nec (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=1)	
Abdomen and pelvic region	Trauma to muscles (n=1)	
Shoulder	Other fractures, nec (n=1) Dislocation (n=3) Trauma to joints and ligaments, nec (n=4) Trauma to joints and ligaments, unspecified (n=2) Traumatic tearing away part of the muscle/ tendon structure, avulsion (n=3) Trauma to muscles (n=3) Trauma to tendon (n=1) Trauma to muscles and tendons, nec (n=6) Trauma to muscles and tendons, unspecified (n=5) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=14)	Joint and other articular cartilage diseases, nec (n=2) Synovitis and tenosynovitis (n=1) Tendinitis (n=15) Frozen shoulder (adhesive capsulitis) (n=2) Muscle/ tendon strain (non-traumatic) (n=7) Bursitis (n=11) Occupational overuse syndrome (n=4) Other specified soft tissue diseases, nec (n=1) Soft tissue diseases due to non-traumatic causes with insufficient information to code as 'other soft tissue disease' or 'diseases involving the synovium and related tissue' (n=6) Musculoskeletal and connective tissue (n=1)
Upper arm		Tendinitis (n=1) Epicondylitis (n=1) Muscle/ tendon strain (non-traumatic) (n=2)

(continued)

	Injury	Disease
Elbow	Other fractures, nec (n=2) Trauma to joints and ligaments, nec (n=1) Trauma to joints and ligaments, unspecified (n=3) Trauma to muscles and tendons, nec (n=1) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=3)	Tendinitis (n=4) Epicondylitis (n=16) Muscle/ tendon strain (non-traumatic) (n=1) Bursitis (n=1) Occupational overuse syndrome (n=2) Soft tissue diseases due to non-traumatic causes with insufficient information to code as 'other soft tissue disease' or 'diseases involving the synovium and related tissue' (n=4)
Forearm	Other fractures, nec (n=5) Trauma to muscles (n=2) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=5)	Tendinitis (n=1) Muscle/ tendon strain (non-traumatic) (n=2) Occupational overuse syndrome (n=2) Soft tissue diseases due to non-traumatic causes with insufficient information to code as 'other soft tissue disease' or 'diseases involving the synovium and related tissue' (n=2)
Wrist	Other fractures, nec (n=3) Trauma to joints and ligaments, nec (n=2) Trauma to joints and ligaments, unspecified (n=1) Traumatic tearing away part of the muscle/ tendon structure, avulsion (n=1) Trauma to muscles (n=1) Trauma to muscles and tendons, nec (n=1) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=6)	Osteoarthritis/ osteoarthrosis (n=1) Synovitis and tenosynovitis (n=6) Ganglion, trigger finger, Dupuytren's contracture (n=1) Tendinitis (n=2) Epicondylitis (n=1) Muscle/ tendon strain (non-traumatic) (n=2) Occupational overuse syndrome (n=3) Musculoskeletal and connective tissue diseases, unspecified (n=1)
Hand, fingers and thumb	Other fractures, nec (n=6) Dislocation (n=1) Trauma to joints and ligaments, nec (n=4) Trauma to joints and ligaments, unspecified (n=2) Traumatic tearing away part of the muscle/ tendon structure, avulsion (n=1) Trauma to muscles (n=3) Trauma to tendon (n=1) Trauma to muscles and tendons, nec (n=5) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=11)	Osteoarthritis/ osteoarthrosis (n=2) Acquired musculoskeletal deformities (n=1) Synovitis and tenosynovitis (n=6) Ganglion, trigger finger, Dupuytren's contracture (n=4) Tendinitis (n=3) Epicondylitis (n=1) Muscle/ tendon strain (non-traumatic) (n=2) Diseases of muscle, tendon and related tissue, nec (n=1) Occupational overuse syndrome (n=5) Complex regional pain syndrome (n=1) Other specified soft tissue diseases, nec (n=1) Soft tissue diseases due to non-traumatic causes with insufficient information to code as 'other soft tissue disease' or 'diseases involving the synovium and related tissue' (n=2)
Upper limb – multiple locations	Trauma to joints and ligaments, unspecified (n=1) Traumatic tearing away part of the muscle/ tendon structure, avulsion (n=1) Trauma to muscles (n=1) Trauma to tendon (n=1) Trauma to muscles and tendons, nec (n=2) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=8)	Tendinitis (n=5) Epicondylitis (n=1) Occupational overuse syndrome (n=1)
Upper limb – unspecified locations	Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=1)	
Hip	Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=1)	

(continued)

	Injury	Disease
Upper leg	Trauma to muscles (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=2)	
Knee	Other fractures, nec (n=2) Dislocation (n=1) Trauma to joints and ligaments, nec (n=3) Trauma to joints and ligaments, unspecified (n=1) Trauma to muscles (n=1) Trauma to muscles and tendons, nec (n=3) Trauma to muscles and tendons, unspecified (n=2) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=8)	Meniscus degenerate/ detached/ retained/ chronic tear (n=3) Muscle/ tendon strain (non-traumatic) (n=1)
Lower leg	Trauma to joints and ligaments, unspecified (n=2) Trauma to muscles (n=1) Trauma to muscles and tendons, unspecified (n=2) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=1)	Joint and other articular cartilage diseases, nec (n=1) Muscle/ tendon strain (non-traumatic) (n=1)
Ankle	Other fractures, nec (n=2) Trauma to joints and ligaments, nec (n=4) Trauma to joints and ligaments, unspecified (n=2) Trauma to muscles (n=2) Trauma to muscles and tendons, nec (n=3) Trauma to muscles and tendons, unspecified (n=2) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=9)	Muscle/ tendon strain (non-traumatic) (n=1) Occupational overuse syndrome (n=3)
Foot	Other fractures, nec (n=3) Trauma to joints and ligaments, nec (n=1) Trauma to joints and ligaments, unspecified (n=2) Trauma to muscles and tendons, nec (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=3)	Muscle/ tendon strain (non-traumatic) (n=1)
Lower limb – multiple locations		Muscle/ tendon strain (non-traumatic) (n=1)
Lower limb – unspecified locations	Other fractures, nec (n=1)	
Neck and trunk	Trauma to joints and ligaments, nec (n=3) Trauma to muscles (n=2) Trauma to muscles and tendons, unspecified (n=2) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=2)	Neck pain, cervicalgia (n=2)
Trunk and limbs	Other fractures, nec (n=1) Trauma to muscles and tendons, unspecified (n=3) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=3)	Tendinitis (n=1) Soft tissue diseases due to non-traumatic causes, nec (n=1)

(continued)

	Injury	Disease
Upper and lower limbs	Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=2)	Muscle/ tendon strain (non-traumatic) (n=1)
Neck and shoulder	Trauma to joints and ligaments, unspecified (n=1) Trauma to muscles (n=2) Trauma to muscles and tendons, nec (n=3) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=6)	Occupational overuse syndrome (n=1)
Other specified multiple locations	Other fractures, nec (n=1) Trauma to joints and ligaments, nec (n=1) Trauma to joints and ligaments, unspecified (n=2) Trauma to muscles (n=2) Trauma to muscles and tendons, nec (n=1) Trauma to muscles and tendons, unspecified (n=2) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=3)	Muscle/ tendon strain (non-traumatic) (n=2) Other specified soft tissue diseases, nec (n=1)
Unspecified multiple locations	Trauma to muscles (n=1) Trauma to muscles and tendons, unspecified (n=1) Soft tissue injuries due to trauma or unknown mechanisms with insufficient information to code elsewhere (n=1)	

Notes: nec indicates not elsewhere classified

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