

# Quantifying the Employer Burden of Persistent Musculoskeletal Pain at a Large Employer in the United Kingdom

## *A Non-interventional, Retrospective Study of Rolls-Royce Employee Data*

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### INTRODUCTION

**Objective:** To quantify the burden of work-relevant persistent musculoskeletal (MSK) pain to a large UK employer. **Methods:** A retrospective, longitudinal, analytical cohort study using linked Rolls-Royce data systems. Cases were employees with a MSK-related referral to occupational health; controls were age-, sex-, and job role-matched employees without such a referral. Outcomes were compared during 12 months' follow-up. **Results:** Overall, 2382 matched case-control pairs were identified (mean age: 46 y; 82% male). Cases took 39,200 MSK-related sickness absence days in total (equating to £50 million in sickness absence costs). Cases took significantly more all-cause sickness absence days than controls (82,341 [£106 million] versus 19,628 [£26 million];  $P < 0.0001$ ). **Conclusions:** Despite access to extensive occupational health services, the burden of work-relevant persistent MSK pain remains high in Rolls-Royce. There is a clear need to better understand how to effectively reduce this burden.

**Keywords:** cost analysis, disease burden, musculoskeletal pain, retrospective, sickness absence

The personal, economic, and societal burden of musculoskeletal (MSK) pain conditions is substantial and increasing.<sup>1</sup> MSK conditions, such as low back pain, neck pain, osteoarthritis, and rheumatoid arthritis, are estimated to affect approximately 1.7 billion people worldwide<sup>2</sup> and 18.8 million people in the UK.<sup>3</sup> As shown by the Global Burden of Disease Study, MSK conditions are the leading cause of years lost to disability worldwide; this burden is expected to increase in line with life expectancy.<sup>4,5</sup> The true prevalence of MSK conditions may be higher than these estimates, because current data are likely an underestimate of both the prevalence and burden of MSK pain conditions.<sup>6</sup>

Poor health associated with persistent MSK pain affects people's lives in many ways, by causing pain and worry, lowering independence, and limiting people's capacity to participate in daily activities, enjoy life, and realize their potential.<sup>7</sup> The economic burden of poor health associated with persistent MSK pain can be immense for the individual and their family and can damage their personal and social well-being.<sup>8</sup> Being unable to maintain regular employment,<sup>9</sup> increased absence due to sickness, and increased inactivity due to disability or early retirement all create financial hardship related to MSK pain.<sup>10,11</sup>

The fiscal impact of persistent MSK pain is also considerable and far-reaching, ranging from reduced employment earnings for individuals, reduced tax contributions to governments, increased burden of state benefits, through to the costs incurred by health services.<sup>12-14</sup> As many work-related activities are dependent on good MSK function, MSK conditions are key causes of work loss through absence.<sup>15</sup> Almost 20% of the estimated 141 million working days lost to sickness or injury in the UK in 2018 were due to MSK conditions.<sup>16</sup> In the UK, 480,000 workers reported work-related MSK conditions in 2019/2020 and an estimated 8.9 million working days were lost as a result of work-related MSK disorders.<sup>17</sup> The economic cost of lost working days and ill-health retirement is substantial. MSK problems can have a substantial impact on work capacity,<sup>18</sup> ultimately leading to ill-health retirement in up to 15% of affected individuals.<sup>19-21</sup> Studies have shown, however, that addressing modifiable health risks, thereby promoting a healthy workforce, can produce substantial cost reductions for employers.<sup>22,23</sup>

Comorbidities, such as cardiovascular disorders (ie, hypertension), digestive system disorders, obesity, neuropsychiatric (depression and anxiety) and sleep disorders, are highly prevalent in individuals affected by MSK conditions.<sup>24-28</sup> Furthermore, studies have demonstrated that the persistence of comorbidities is correlated with worsening of pain and/or physical function<sup>29-33</sup> and that an excessive burden of comorbidity can be associated with adverse health outcomes.<sup>34</sup> Comorbidities, therefore, add to the burden of MSK and represent aspects of the MSK condition that may be improved by holistic intervention measures.

Despite the widely acknowledged extent of MSK pain conditions and their impact on employers,<sup>17,35-38</sup> this is the first study, to the best of our knowledge, to examine the economic impact of

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This study was sponsored by Pfizer and Eli Lilly and Company. Authors affiliated with Pfizer participated in designing the study, interpreting the data, and writing the manuscript, and approved the final version for publication. Medical writing and editorial support was provided by Deirdre Carman PhD (Alispera Communications Ltd) and was funded by Pfizer and Eli Lilly and Company.

Lucy Abraham, Rachel Russell, Craig Beck, and Kate Halsby are employees of and hold stock and/or stock options in Pfizer. Robert Wood, Megan O'Brien, and Lucy Massey are employees of Adelphi Real World, which received funding from Pfizer and Eli Lilly and Company to conduct this study. David Roomes is an employee of and holds stock and/or stock options in Rolls-Royce, and provides ad hoc occupational medicine expert input to Pfizer. Kim Burton is an employee of the University of Huddersfield and is paid by Pfizer for his duties on the STAMPP Steering Committee.

Institutional Review Board approval was not required; all study data were de-identified and anonymized by Rolls-Royce before data transfer and analysis. Access to the study data was approved by Rolls-Royce's Chief Privacy Officer.

Knowing the extent of the burden of work-relevant persistent musculoskeletal pain will help employers design and implement interventions aimed at improving employee health and well-being. This should reduce the impact of musculoskeletal conditions, improve work productivity, and reduce the cost of sickness absence, ultimately helping employees stay in work.

The authors report no conflicts of interest.

Supplemental digital contents are available for this article. Direct URL citation appears in the printed text and is provided in the HTML and PDF versions of this article on the journal's Web site ([www.joem.org](http://www.joem.org)).

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DOI: 10.1097/JOM.0000000000002468

these conditions on employers using real-world data. Rolls-Royce plc in the UK (hereafter referred to as Rolls-Royce) already has measures in place to support employees with MSK pain, including access to Occupational Health (OH), specialist ergonomic assessment and advice, workplace adjustments and accommodations, and provision of specialist equipment where required. Despite these interventions, the company experiences considerable sickness absence and associated costs (as yet unquantified) arising from these conditions. Rolls-Royce wished to understand the basis of MSK-related sickness absence and associated costs and to use this knowledge to explore implementation of further supportive interventions to effectively reduce the impact on both employees and the employer. Preliminary internal analysis of sickness absence data by the in-house OH team had confirmed that the impact was significant and warranted further detailed and systematic analysis.

Addressing sickness absences by reducing the impact of MSK conditions therefore has the potential to be cost saving for employers. However, to address this issue, a thorough understanding of MSK-related burden in the workforce is first needed from the employer’s perspective. The primary objective of the present study was to quantify the impact of work-relevant persistent MSK pain from the employer’s perspective using Rolls-Royce OH referrals and sickness absence data. The term “work-relevant” is used here to distinguish between those symptoms that interfere with or are provoked by work, and everyday aches and pains: unlike work-related, work-relevant does not imply causation. Secondary objectives were to estimate the cost of work-relevant persistent MSK pain on the employer, to describe the affected employees’ characteristics, and to describe the prevalence of work-relevant persistent MSK pain in the workplace. Exploratory objectives were to assess the primary endpoints in employees with specific MSK conditions, to examine the relationship between work-relevant persistent MSK pain and mental health conditions and workplace safety incidents, and to quantify the extent of ill-health retirement resulting from work-relevant persistent MSK pain in this employee population. In-depth awareness of the burden of work-relevant persistent MSK pain will assist in the implementation of interventions aimed at improving employee health and well-being, thereby reducing the impact of MSK conditions and improving work productivity, reducing the cost of sickness absence, and ultimately helping employees stay in work.

## METHODS

### Study Design and Patients

This was a retrospective, longitudinal cohort study with a control group. The study used Rolls-Royce’s linked OH, Human Resources (HR), and Health, Safety, and Environment data systems to identify employees referred to OH by their manager for an MSK condition, which is being used here as a proxy for work-relevant persistent MSK pain. OH services are primarily delivered on-site to consistent protocols; however, employees based at smaller sites may

have to travel to a referral center if they need to be assessed and this cannot be done remotely.

Employees fulfilling all selection criteria (subsequently referred to as “cases”) were indexed on the date of their first/earliest recorded OH referral for an MSK-related diagnosis based on International Classification of Diseases and Related Health Problems 10th revision (ICD-10) codes (Rolls-Royce-specific ICD-10 code of 13.x, ie, “back pain,” “neck pain,” “lower limb disorder,” “upper limb disorder,” “arthritis,” “rheumatism,” or “other MSK and injuries,” but excluding “fracture”) between January 2016 and December 2018 (the “indexing period”). The Rolls-Royce ICD-10 code for fracture (RR\_ICD-10 13.3) was excluded as employees with a fracture would likely experience atypical MSK pain. Employees with pregnancy-related OH referrals or sickness absences recorded at any point within their electronic employee record were excluded because of the atypical MSK pain potentially experienced during pregnancy.

Employees had to have at least 6 months’ continuous employment before the index date (the baseline period) in order to assess baseline characteristics, and at least 12 months’ continuous employment following the index date (follow-up period) for outcomes assessment. Employee records were examined from the later of: the study period start (July 1, 2015) and the date of hire, until either the earlier of: the end of the study period (December 31, 2019) or date of termination of employment with Rolls-Royce (Fig. 1). The study start date was chosen to align with implementation of the current Workday (version R22020; Workday Inc., Pleasanton, CA) module for logging sickness absences. The study end date was chosen to avoid possible implications of structural changes within Rolls-Royce in response to the COVID-19 pandemic. Each case was exactly matched 1:1 on birth year ( $\pm 1$  year), sex, and category of job role (works = factory staff; management = any management grade role; staff = non-works employees not in management grade roles) to an employee with no MSK-related OH referrals during the study period (subsequently referred to as “controls”). Controls, who could have a non-MSK-related OH referral or no OH referrals, were assigned a pseudo-index date equivalent to the index date of the case with whom they were matched and, like cases, were required to have a minimum of 6 months’ employment before the pseudo-index date and  $\geq 12$  months’ continuous employment following the pseudo-index date. Where more than one suitable control was identified for a single case, a single control was chosen at random. One control could be used as a match for more than one case.

The study was conducted in accordance with legal and regulatory requirements, and followed generally accepted research practices described in the Guidelines for Good Pharmacoepidemiology Practices issued by the International Society for Pharmacoepidemiology, and Good Practices for Outcomes Research issued by the International Society for Pharmacoepidemiology and Outcomes Research. Institutional Review Board approval was not required; all study data were de-identified and anonymized by the Rolls-Royce Workday team before data transfer and analysis. The process of de-

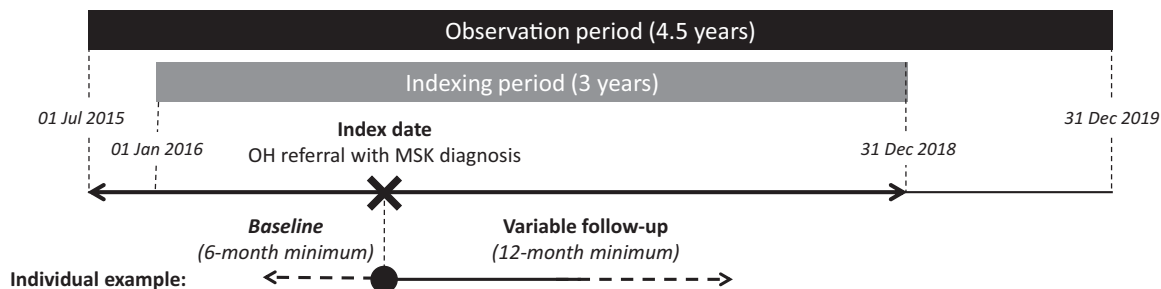


FIGURE 1. Study design. MSK, musculoskeletal.

identification/anonymization included generation of a unique identifier per employee via the anonymization of employee numbers, and limiting of key/sensitive dates to month and year only, for example, date of birth, date of hire/termination, etc. Approval for access to de-identified and anonymized employee records for the purposes of this study was provided by the Rolls-Royce Chief Privacy Officer.

A steering committee, which included independent experts in OH, MSK pain, and pain management, reviewed and approved the study protocol, provided methodological and analytical advice, and helped to interpret the data.

## Data Sources

Linked electronic employee records from three separate Rolls-Royce data systems were used: HR (Workday version R22020), OH (Cority version 2021.1.2; Cority Software Inc., Toronto, Canada), and Health, Safety, and Environment (Intelex version 6.5.134.0; Intelex Technologies Inc., Toronto, Canada). Employee data were linked between the different data systems via a unique identifier common to each data system, which enabled access to and analysis of the endpoints of interest for this study (ie, demographics, sickness absences, OH details, safety records, etc.) at the individual level.

## Workday

Rolls-Royce uses Workday software to record basic demographic (age and sex) and employee details including dates of employment, employment status, sector, site, and location. This information is entered by the employee and/or their manager following prompts/guidance from the system to ensure recorded information is of good quality and complete. Workday also captures sickness absence data, including high-level information such as diagnosis/reason for absence and length of absence. Diagnoses/reasons were self-coded according to the 23-category, Level 1 Sickness Absence Recording Tool (SART) coding scheme.<sup>39</sup> This coding scheme is based on high-level ICD-10 codes. All employees had access to, and could input data into, their own profile on Workday. Additionally, line managers could input data on members of their teams. Workday can only capture one diagnosis per episode; consequently, it is not possible to differentiate between single-cause absences and those caused by multi-morbidities.

## Cority

The Cority data system is used by Rolls-Royce to manage OH referrals and consultations. Key information relating to each case is captured including the date the case opened/closed, diagnosis, date of diagnosis, work-related (or not), pre-existing (or not), and case/clinical visit notes. An employee does not need to be absent to be referred to OH. Referrals are made by managers as a result of absence, inability to meet work demands, or specialist assessment, among other reasons; employees can also request a referral. All employees referred to OH will consult with an OH clinician either physically or virtually, after which a diagnosis will be recorded (ie, not at referral). Diagnoses are coded by OH clinicians based on high-level ICD-10 codes that are more detailed than the SART coding scheme used in Workday.

Because diagnoses in Workday could be quite diverse and inconsistent in terminology and were self-reported by the employee (typically based on a clinician's certificate), Cority was used as the primary data source in this study to identify employees with work-relevant persistent MSK pain.

Ill-health retirements, where recorded, are also captured within Cority with an associated ICD-10 code (ie, the medical reason for ill-health retirement).

## Intelex

The Intelex system captures data relating to workplace safety incidents as defined within the Rolls-Royce Health, Safety and

Environment Management System. Broadly, the types of incidents recorded include major, minor, first aid, near-miss, and high-potential incidents. Metadata regarding the date, time, location, and business area are also captured. Data may be entered by any employee in order to encourage and facilitate incident reporting, but the majority of incidents are recorded by site-based safety professionals. Irrespective of who enters data, all inputs are centrally validated on a weekly basis at a data quality-assurance meeting of senior Health and Safety professionals.

## Outcomes

Study outcomes included: OH referrals (frequency, duration [once opened, an OH referral remained open until resolved], and diagnosis [RR\_ICD-10]); sickness absences (frequency, duration, and reason [SART Level 1]); costs of sickness absences (direct, indirect, and total costs); prevalence by calendar year, sex, age group, and job role; mental health status (frequency/duration of OH referrals and sickness absences specific to mental health conditions); workplace safety incidents (frequency, classification, high potential, major injury, and nature); and ill-health retirement (frequency and cause).

Most published sickness absence cost data are based on estimates of the direct salary costs of absent employees and vary according to several factors, including whether a replacement for the absent employee is needed, the degree of retraining needed, and overtime costs incurred if another employee covers the work that would have been done by the absent employee.<sup>40</sup> Rolls-Royce employees are highly trained and specialized aerospace industry employees and covering their absence was considered to incur substantial costs. In this study, the costs of sickness absences were defined as the sum of direct labor costs and indirect productivity costs. Direct labor costs were calculated as the product of sickness absence days and daily staff rates, whereby daily staff rates accounted for salary, pension/benefits, rewards, and expenses/overheads. Indirect costs were derived from direct labor costs in this analysis and were assumed to be up to three times that of the direct labor costs based on the highly skilled and technical staff employed by Rolls-Royce; a multiplier historically accepted in the OH community and explored in the sensitivity analyses described below (David Roomes; personal communication via email on August 3, 2020). Indirect costs were expected to encompass substitute labor, that is, overtime for colleagues to cover absence or temporary contract costs, retraining, lost productivity, ill-health benefits, quality defects, rework, safety incidents, and idle capital assets.<sup>41</sup>

## Statistical Analysis

This study was primarily descriptive in nature. Base size, frequency, and percentages were reported for nominal variables; base size, mean, median, standard deviation (SD), 25th and 75th percentiles, minimum and maximum values were reported for numeric variables.

Outcomes were assessed over the entire follow-up period and compared between subgroups at the 12-month follow-up. Landmark analyses were also performed at other pre-specified time points for completeness (6 and 24 months). Employees had to be observed (ie, in employment) for the full time period to be included in each landmark analysis.

Owing to the lack of studies calculating the cost of sickness absence in similar working environments, the potential for overestimation of indirect costs was recognized and a sensitivity analysis conducted based on the assumption that the indirect costs were a considerably lower component of the overall cost of sickness absence. In this analysis, the indirect productivity cost was assumed to be 0.3 times that of the direct labor cost based on nine prior studies of direct and indirect costs due to sickness absence.<sup>40</sup>

All statistical tests were two-sided in nature; a significance level of  $P < 0.01$  was used. No corrections were made for multiple comparisons. Standard statistical tests (eg, Student's *t* test, analysis of variance) were used for comparisons.

Analyses were performed using Stata (version 16.1; Stata-Corp LLC, College Station, TX).

## RESULTS

### Study Participants

Overall, 47,441 UK Rolls-Royce employee records were extracted for this study. Applying all eligibility criteria resulted in a final study cohort of 2382 matched pairs of cases and controls (Fig. 2)—the 2382 controls comprised 2167 unique employees.

Demographic and clinical characteristics of the overall sample are summarized in Table 1. The mean age at indexing for cases and controls was 46.3 (SD 11.2) years. Most participants were male (81.7%) and white (cases: 87.8%; controls: 91.5%), and the mean duration of employment was 16.5 years for cases and 17.1 years for controls. The mean (SD) duration of follow-up was 30.5 (10.5) months for cases and controls, with almost two-thirds (63.7%) of matched case-control pairs having at least 24 months of follow-up. Where significant differences were observed (ie, ethnicity, employee type permanent, business sector, and site; all  $P < 0.0001$  for cases vs

controls), absolute differences were small in magnitude and therefore unlikely to represent clinically meaningful differences.

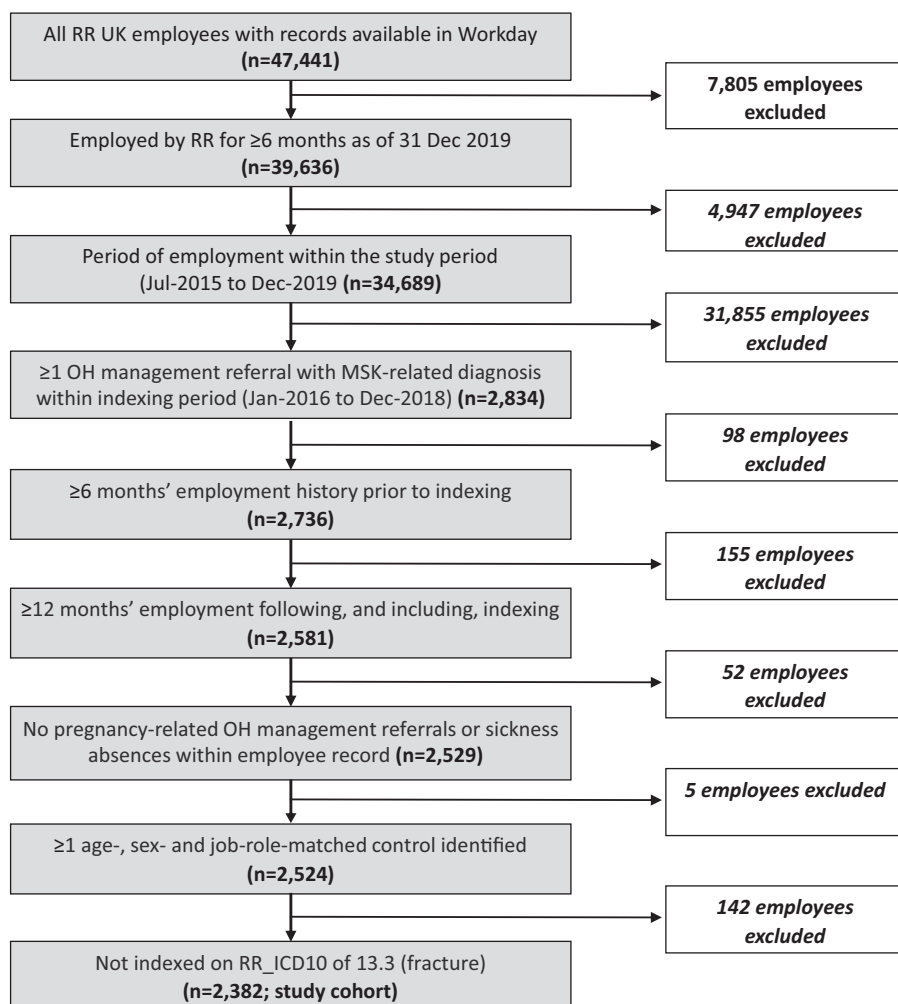
### OH Referrals

The 2382 cases were referred to OH a total of 2902 times over the 12-month follow-up period (Table 2). The mean (SD) number of MSK-related OH referrals over the 12-month period was 1.2 (0.5) in cases; 439 cases (18.4%) had an additional MSK-related OH referral following indexing. The most frequently recorded reasons for MSK-related OH referrals were “back pain” ( $n = 880$ ; 36.9% of cases with at least one instance of referral), “lower limb disorder” ( $n = 580$ ; 24.3%), and “upper limb disorder” ( $n = 503$ ; 21.1%).

There were 3136 all-cause (including MSK) OH referrals among cases and 135 all-cause OH referrals among controls during the 12-month follow-up period. The mean number (SD) of all-cause OH referrals was 1.3 (0.6) for cases and 0.1 (0.3) for controls ( $P < 0.0001$ ). Non-MSK reasons for OH referrals did not differ significantly between cases and controls at the 12-month timepoint (Table 2). OH referrals across all timepoints are shown in Supplementary Table 1, <http://links.lww.com/JOM/B70>.

### Sickness Absence

Over the 12-month follow-up period, 807 cases (33.9%) took at least one MSK-related sickness absence (Table 3). The mean (SD)



**FIGURE 2.** Study flow. ICD10, International Statistical Classification of Diseases and Related Health Problems, 10th Revision; MSK, musculoskeletal; OH, occupational health; RR, Rolls-Royce.

**TABLE 1.** Employee Demographics and Employment Characteristics

Characteristic	Cases (n = 2382)	Controls (n = 2382)
Age at indexing, y*		
Mean (SD)	46.3 (11.2)	46.3 (11.2)
Median (IQR)	48.0 (38.0–55.0)	48.0 (38.0–55.0)
Range	17–69	17–70
Male, n (%) <sup>†</sup>	3892 (81.7)	
Ethnicity white, n (%) <sup>‡</sup>	1922 (87.8) <sup>a</sup>	1883 (91.5)
Follow-up duration, mo		
Mean (SD)	30.5 (10.5)	30.5 (10.5)
Median (IQR)	30.3 (21.4, 40.0)	30.5 (21.3, 39.8)
Range	12.1, 47.9	12.0, 47.9
24 months' follow-up, n (%) <sup>†</sup>	3038 (63.7)	
Rolls-Royce business sector, n (%)	a	
Civil	1809 (75.9)	1734 (72.8)
Defense	422 (17.7)	451 (18.9)
Central	130 (5.5)	133 (5.6)
Other	21 (0.9)	64 (2.7)
Employment duration, y		
Mean (SD)	16.5 (11.9)	17.1 (12.3)
Median (IQR)	13.0 (5.9, 26.6)	14.8 (6.2, 27.0)
Range	0.5–49.4	0.5–48.9
Employment permanent, n (%)	2378 (99.8) <sup>a</sup>	2323 (97.5)
Job role, n (%) <sup>†</sup>		
Works	2392 (50.2)	
Staff	1810 (38.0)	
Management	562 (11.8)	
Site, n (%)	a	
Derby	1573 (66.0)	1192 (50.0)
Bristol	219 (9.2)	306 (12.9)
Inchinnan	117 (4.9)	185 (7.8)
Barnoldswick	154 (6.5)	160 (6.7)
Birmingham	55 (2.3)	133 (5.6)
Other	264 (11.1)	406 (17.0)

IQR, interquartile range; SD, standard deviation.

\*Controls were allowed to be within ±1 year of the age of the matched case.

<sup>†</sup>Matching variable for cases and controls.

<sup>‡</sup>Ethnicity was missing for 325 controls and 193 cases.

<sup>a</sup>P < 0.0001 versus controls.

number of MSK-related sickness absence days was 16.5 (45.2) per case, equating to 39,200 working days lost due to MSK. Notably, the mean was 48.6 days (almost three times higher) among the 807 who took at least one sickness absence day.

Over the 12-month follow-up, significantly more cases than controls had a sickness absence day for any reason (n = 1774 [74.5%] vs n = 1049 [44.0%] for controls; P < 0.0001) (Table 3). Cases had a significantly higher mean (SD) number of all-cause sickness absence days than controls (34.6 [62.1] vs 8.2 [31.2] days, respectively; P < 0.0001), equating to 82,341 and 19,628 days lost, respectively (P < 0.0001). Reasons for all-cause sickness absence at the 12-month follow-up are shown in Fig. 3. Cases had significantly more diagnosed back problems, other MSK problems, and injuries/fractures than controls (all P < 0.0001). Notably, some MSK-related sickness absences were observed in controls, suggesting acute rather than persistent problems. Sickness absence data across all timepoints are shown in Supplementary Table 2, <http://links.lww.com/JOM/B70>.

**Cost of MSK-Related and All-Cause Sickness Absences**

The mean (SD) cost of MSK-related sickness absences over the 12-month follow-up period was £21,032 (£58,674) per employee (direct costs of £5258 [£14,668] and indirect costs of

£15,774 [£44,005] per employee), for a total cost of £50,099,376 (Table 4; Supplementary Fig. 1, <http://links.lww.com/JOM/B70>). The mean (SD) cost per employee of all-cause sickness, including MSK-related sickness, was £44,319 (£80,756) for cases (direct costs of £11,080 [£20,189] and indirect costs of £33,239 [£60,567] per employee) and £10,779 (£44,682) for controls (direct costs of £2695 [£11,171] and indirect costs of £8085 [£33,512] per employee), for a total cost of £105,567,360 and £25,676,428, respectively, over the 12-month period (P < 0.0001). MSK-related sickness absence costs accounted for 47.5% of the total cost of sickness absence in cases at the 12-month follow-up.

**Prevalence of MSK-Related Pain**

The prevalence of work-relevant persistent MSK pain, as reflected by OH referrals for an MSK condition, increased over the study period, ranging from 3.5% in 2016 (1201 of 34,179 employees) to 4.1% in 2017 (1347 of 32,532 employees), 3.9% in 2018 (1196 of 30,353 employees), and 4.7% in 2019 (1263 of 26,751 employees; Supplementary Fig. 2, <http://links.lww.com/JOM/B70>).

**TABLE 2.** OH Referrals in Cases and Controls (12-Month Follow-Up)

Resource	Cases (n = 2382)	Controls (n = 2382)
Index OH referral diagnosis, n (%)		
Back pain	851 (35.7)	–
Lower limb disorder	537 (22.5)	–
Upper limb disorder	464 (19.5)	–
Other MSK and injuries	307 (12.9)	–
Neck pain	111 (4.7)	–
Arthritis	94 (3.9)	–
Rheumatism	18 (0.8)	–
MSK-related OH referrals		
No. of referrals	2902	–
Mean (SD)	1.2 (0.5)	–
Median (IQR)	1.0 (1.0–1.0)	–
Range	1.0–4.0	–
Additional MSK-related OH referrals, n (%)		
Yes	439 (18.4)	–
No	1943 (81.6)	–
MSK-related reason for OH referral, n (%)		
Back pain	880 (36.9)	–
Lower limb disorder	580 (24.3)	–
Upper limb disorder	503 (21.1)	–
Neck pain	123 (5.2)	–
Arthritis	108 (4.5)	–
Rheumatism	21 (0.9)	–
Other MSK and injuries	331 (13.9)	–
Number of all-cause OH referrals		
No. of referrals	3136	135
Mean (SD)	1.3 (0.6) <sup>a</sup>	0.1 (0.3)
Median (IQR)	1.0 (1.0–2.0)	0.0 (0.0–0.0)
Range	1.0–4.0	0.0–3.0
Non-MSK reasons for OH referral, n (%)		
Anxiety	34 (1.4)	16 (0.7)
Depression	31 (1.3)	18 (0.8)
Stress	17 (0.7)	19 (0.8)
Unspecified surgery/post-operation	23 (1.0)	8 (0.3)
Neurological	10 (0.4)	12 (0.5)
Cardio/cerebrovascular	16 (0.7)	8 (0.3)
Gastrointestinal	9 (0.4)	8 (0.3)
Other	12 (0.5)	2 (0.1)
Other psychiatric/mental health	6 (0.3)	4 (0.2)

IQR, interquartile range; MSK, musculoskeletal; OH, occupational health; SD, standard deviation.

<sup>a</sup>P < 0.0001 versus controls.

**TABLE 3.** Sickness Absence Days in Cases and Controls (12-Month Follow-Up)

Outcome	Cases (n = 2382)	Controls (n = 2382)
MSK-related sickness absence days		
No. of employees with ≥1 sickness absence day (%)	807 (33.9)	–
No. of days	39,200	–
Mean (SD)	16.5 (45.2)	–
Median (IQR)	0.0 (0.0–7.0)	–
Range	0.0–366.0	–
All-cause sickness absence days		
No. of employees with ≥1 sickness absence day (%)	1774 (74.5) <sup>a</sup>	1049 (44.0)
No. of days	82,341	19,628
Mean (SD)	34.6 (62.1)	8.2 (31.2)
Median (IQR)	8.0 (0.0–39.0)	0.0 (0.0–5.0)
Range	0.0–366.0	0.0–366.0

IQR, interquartile range; MSK, musculoskeletal; SD, standard deviation.

<sup>a</sup>*P* < 0.0001 versus controls.

Work-relevant persistent MSK pain was more common among employees in works roles compared with those in staff and management roles (Supplementary Fig. 3, <http://links.lww.com/JOM/B70>). The prevalence of MSK pain according to age and sex in the different roles is shown in Supplementary Fig. 3, <http://links.lww.com/JOM/B40>.

### Exploratory Objectives

#### Work-Relevant Persistent MSK Pain Associated with Specific OH Diagnoses

The numbers of OH referrals and sickness absence days for employees with specific MSK-related diagnoses from OH are shown in Supplementary Table 3, <http://links.lww.com/JOM/B70>. Conditions associated with the highest mean numbers of sickness absence days were rheumatism (mean 69.2; SD 121.2 days) and arthritis (mean 45.4; SD 86.4 days).

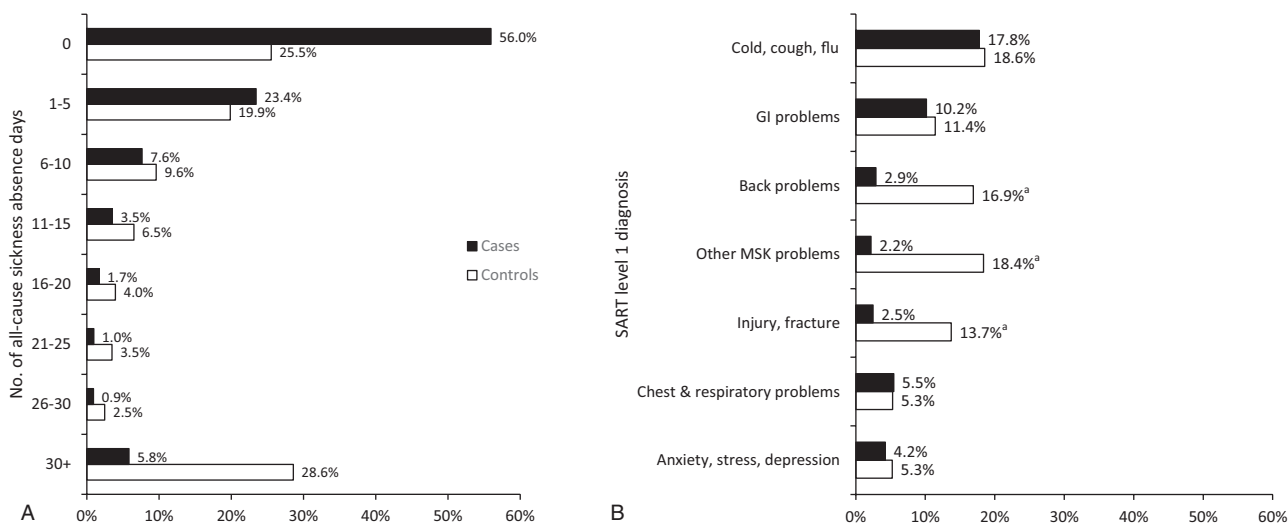
#### MSK Pain and Mental Health Conditions

Across the 12-month follow-up period, 84 cases (3.5%) and 54 controls (2.3%) were referred to OH for reasons relating to their

mental health. The mean (SD) number of mental health-related OH referrals was 0.04 (0.22) for cases and 0.03 (0.18) for controls (*P* = 0.0115). The most frequently recorded diagnoses for mental health-related OH referrals were anxiety, depression, and stress (*n* = 34, *n* = 31, and *n* = 17, respectively, for cases; *n* = 16, *n* = 18, and *n* = 19, respectively, for controls). Across the entire follow-up period, 234 cases were referred to OH for reasons relating to their mental health, of whom 198 (84.6%) had such a referral within 12 months of an MSK-related referral/absence.

Mental health-related sickness absence days were taken by 125 cases (5.2%) and 101 controls (4.2%) across the 12-month follow-up period. The mean (SD) number of mental health sickness absence days taken in this time period was 3.4 (22.7) for cases and 2.4 (19.6) for controls.

The mean (SD) cost per employee of mental health-related sickness absences was £4467 (£30,277) for cases and £3095 (£26,207) for controls, for a total cost of £10,639,504 and £7,372,276, respectively, across the 12-month follow-up period (Table 4). Mental health-related sickness absence costs accounted for 13.7% of the total cost of sickness absence across the whole cohort (£3780/£27,549), 10.1% in cases (average annual cost of



**FIGURE 3.** (A) Number of and (B) reason for all-cause sickness absences at 12-month follow-up. GI, gastrointestinal; MSK, musculoskeletal; SART, Sickness Absence Recording Tool. <sup>a</sup>*P* < 0.0001 versus controls.

**TABLE 4.** Cost of MSK-Related, All-Cause, and Mental Health-Related Sickness Absences Over the 12-Month Follow-Up Period

Cost*	Cases (n = 2382)	Controls (n = 2382)
MSK-related cost, £		
Cost for all employees	50,099,376	–
Mean cost per employee (SD)	21,032 (58,674)	–
All-cause cost, £		
Cost for all employees	105,567,360 <sup>a</sup>	25,676,428
Mean cost per employee (SD)	44,319 (80,756)	10,779 (44,682)
Mental health-related cost, £		
Cost for all employees	10,639,504	7,372,276
Mean cost per employee (SD)	4467 (30,277)	3094 (26,207)

MSK, musculoskeletal; SD, standard deviation.

\*Job role-specific daily rates were used to derive costs. Total costs included direct and indirect costs; indirect costs were assumed to be 3 × direct costs.

<sup>a</sup>*P* < 0.0001 versus controls.

mental-health-related sickness/average annual cost of sickness absence per employee: £4467/£44,319) and 28.7% in controls (£3094/£10,779) at the 12-month follow-up. Controls do not have a large proportion of MSK-related costs and therefore their mental health-related costs comprise a larger proportion of their overall costs.

### Relationship between Work-Relevant Persistent MSK Pain and Workplace Safety Incidents

Workplace incidents were experienced by 76 cases (3.2%) and 32 controls (1.3%) during the 12-month follow-up; cases had more than twice as many incidents as controls (81 vs 36). The most frequently reported workplace incidents for cases and controls were “sharp edges, burrs, etc.” (*n* = 6 and *n* = 9, respectively), “slips, trips, and falls” (*n* = 8 and *n* = 5, respectively), and “step on or struck by/against” (*n* = 5 and *n* = 5, respectively).

### Ill-Health Retirements

Ill-health retirements were observed in 33 cases (1.4%) and nine controls (0.4%) across the entire follow-up period. Of the 33 ill-health retirements observed among cases, 15 (45.5%) had a recorded diagnosis code relating to ICD-10 Chapter XIII “diseases of the MSK system and connective tissue.”

### Sensitivity Analysis of Costs Associated with Work-Relevant Persistent MSK Pain

This analysis used an alternative multiplier to the three-times direct costs to calculate the indirect costs of sickness absence in the primary analysis. Using a multiplier of 0.3, the mean (SD) cost of MSK-related sickness absence over the 12-month follow-up period was reduced to £6836 (£19,069) per employee, for a total cost of £16,282,297.

The mean (SD) cost per employee over the 12-month period for all-cause sickness absence was £14,404 (£26,246) for cases and £3503 (£14,522) for controls, resulting in total costs over 12 months of £34,309,392 and £8,344,839, respectively (*P* < 0.0001). The mean cost (SD) of mental health sickness absence days was £1452 (£9840) for cases and £1006 (£8517) for controls, resulting in total costs of £3,457,838 and £2,395,990, respectively.

## DISCUSSION

This study, one of the first of its kind to use real-world employee data, was undertaken to help Rolls-Royce understand the impact and burden of work-relevant persistent MSK pain and to

consider additional interventions over and above the traditional workplace adaptations, providing a more holistic disease-management program. The study used linked data systems to generate a detailed and robust picture of the consequences for employers of MSK conditions, focusing on the economic cost and prevalence of sickness absence and characterizing groups of employees making the greatest contribution to the overall cost of MSK-related absences.

Despite the availability and use of industry-leading OH systems and referral processes, MSK-related pain among Rolls-Royce employees had a considerable impact from the employer’s perspective. Employees with work-relevant persistent MSK pain had statistically significantly higher rates of OH referrals, mental health-related OH referrals, and sickness absence days, and statistically significantly higher sickness absence costs versus controls, in line with previous findings.<sup>42</sup> Links between these outcomes and business performance, where workforce health results in reduced productivity, have been reported previously,<sup>43</sup> underscoring the importance of optimizing employee health in the workplace.

Sickness absence is a key concern for all employers, who are under increasing pressure to optimize productivity and for whom high levels of employee attendance are critical. In the present study, cases on average took 16.5 MSK-related sickness absences, equating to 39,200 lost working days as a result of MSK conditions. Furthermore, cases took significantly more sickness absences for any reason than matched controls across all time periods, although only 18% had repeat MSK-related OH referrals during the 12-month follow-up period.

The economic cost to Rolls-Royce of MSK-related absences was considerable. MSK-related sickness absences cost Rolls-Royce £21,032 per case over the 12-month period, equating to over £50 million across this period. All-cause sickness absence costs were statistically significantly higher for cases (those with work-relevant persistent pain) versus matched controls across all time periods. Notably, MSK-related sickness absence costs accounted for almost half of the overall cost of sickness absence in cases.

In calculating the costs associated with sickness absence, indirect costs were defined as three times the direct costs incurred. In this analysis, as in the primary analysis, employees with work-relevant persistent MSK pain were associated with substantially higher costs to the employer than those who did not present to OH with work-relevant persistent MSK pain. The sensitivity analysis, which assumed a multiplier of 0.3 rather than 3, was based on an average of indirect costs used across nine case studies described by Bevan and Hayday; these ranged from 7% to 55% of the direct costs across a variety of workplaces, none of which were directly comparable with the Rolls-Royce workforce.<sup>40</sup> Even using this very conservative multiplier, costs were statistically significantly higher for cases versus controls.

Mental health conditions and OH referrals were more common in the MSK case cohort than in the control cohort of employees who did not have an MSK-related OH referral, although it was not possible to determine whether the mental health condition preceded the MSK condition or vice versa. Sickness absence days due to mental health conditions were also more common in cases than controls: the proportion of cases taking sickness absences for “anxiety, stress, depression” over longer-term follow-up was significantly higher versus controls (*P* < 0.0001). The financial cost of sickness absence days resulting from mental health conditions, although substantially less than the costs arising from MSK conditions, nonetheless represented approximately 10% of the overall cost of sickness absence in cases. The higher costs in cases compared with controls may be explained in part by a higher prevalence of comorbidities given the increased number of non-MSK OH referrals and sickness absences in cases versus controls. MSK conditions are known to have a significant impact on mental

health and evidence supports the coexistence of these two conditions being a significant factor inhibiting early return to work.<sup>35,44</sup> In line with our findings, others have shown that individuals living with persistent MSK pain are more likely to have anxiety and depression than those who do not have persistent pain.<sup>26,45–48</sup> An analysis of the US National Health and Nutrition Examination Survey data demonstrated an increased risk of major depression in individuals with arthritis.<sup>49</sup> Furthermore, an association between long-term sickness absence, depressive symptoms, and MSK pain has been identified in Danish healthcare workers.<sup>50</sup> These data underscore the importance of supporting employees experiencing MSK pain with their mental health, and of working with these employees to find suitable interventions or adjustments as early as possible if mental health issues do arise. Further examination of the contribution of comorbid conditions to the overall cost of sickness absence in employees with work-relevant persistent MSK pain may also be warranted.

This study also examined the relationship between MSK conditions and workplace safety incidents. Although few such incidents were observed during the 12-month follow-up, a difference between cases and controls was observed, with twice as many incidents in cases as controls (81 vs 36). Employers have a duty of care to provide their employees with a safe working environment, which they fulfill through a variety of workplace assessments, implementation of controls, provision of guidance, and changed work practices. This neglects the wider issue of work-associated factors, such as the impact of an employee's health on health and safety in the workplace. Few studies have examined the interplay of physical and psychosocial safety climates, although research by McLinton and colleagues in the healthcare setting identified a combination of safety climates that significantly predicted objective outcomes from hospital safety system records on staff accidents, absence, and quality of care, suggesting a dynamic interplay in the prediction of impacts on the worker, organization, and end user.<sup>51</sup> Knowledge and training are needed so that managers are aware of their health and safety responsibilities, especially in the context of MSK, and know how to support employees; employees likewise need to understand MSK health, risk factors at work, and how to help themselves.<sup>52</sup> Supportive employers can make a difference through careful workplace design, ensuring supportive line management, and implementing policies to encourage good MSK health.<sup>8</sup>

Some limitations of the study should be considered. The study design was based on the assumption that an MSK-related OH referral was triggered by persistent pain associated with an MSK condition, as opposed to an acute episode. Persistent pain is defined as pain that lasts for 3 months or more,<sup>53</sup> likely impacting on the employee's ability to do their job, and likely to result in referral to OH. In contrast, acute pain of short duration would likely not trigger an OH referral and experience within Rolls-Royce suggests that referrals due to acute events are uncommon. Some underestimation of sickness absence may have occurred because it is known that a substantial proportion of employees go to work when unwell,<sup>54</sup> as such employees with manageable persistent MSK pain would not have been referred to OH. In addition, this study did not account for employees whose condition impacted on the employer but who chose not to report to OH; however, the impact of this missing employee subpopulation is likely to be limited. Although supporting employees with work-relevant persistent MSK pain is key to reducing sickness absence costs, identification of the unseen employee with manageable MSK pain would further help reduce costs and improve employee well-being. Furthermore, measurements of body mass index were not collected in this study, making it difficult to identify links between obesity and MSK pain in the workplace.

The generalizability of these data may be limited as the study cohort worked for a single employer and were a highly skilled,

predominantly white, middle-aged, and male workforce. In addition, Rolls-Royce employees had access to OH services. Nonetheless, MSK-related pain had a large impact in this setting. Available evidence suggests that persistent MSK pain is significantly worse in lower socioeconomic groups, socially deprived areas, and in areas of low socioeconomic status,<sup>55</sup> suggesting that the impact of MSK-related pain may be greater in less highly skilled employees in other industries and settings<sup>56</sup> and in those working for companies with less extensive OH support. As only 50% of employees report having access to OH services through their employer,<sup>57</sup> this factor may have considerable impact on sickness absence resulting from MSK pain.

Another potential limitation relates to how well employee data were recorded. Despite quality-assurance processes in place at Rolls-Royce, the quality of Workday data is dependent on the manager capturing and recording all sickness absence data. Furthermore, some of the codes used to define MSK-related events were not exclusive to MSK conditions. For example, the code "lower limb disorders" could include sprains, strains, and joint replacements, as well as medical issues affecting the lower limb, such as deep-vein thromboses and wounds, among others. Therefore, there may have been some misclassification arising from the breadth of conditions covered by the codes used.

Despite the high prevalence of MSK conditions among people of working age and that almost two-thirds of years lost to poor health occur in working-age people,<sup>58</sup> few studies have examined the impact of MSK pain in the workplace from the employer's perspective. To the best of our knowledge, this is one of the most comprehensive such studies, strengthened by the connectivity between various reporting systems within Rolls-Royce. Quality-assurance measures in place in Rolls-Royce ensure good consistency in the data collected. Use of a control group helped identify aspects of MSK-related sickness absence relative to employees who did not have these conditions. A follow-up to this study is underway involving a cross-sectional survey aiming to understand experiences of Rolls-Royce employees with and without MSK pain; the results of that study should address some of the knowledge gaps identified in the present study.

Increased awareness of how we value health as a society impacts on how employers make investment decisions designed to improve health outcomes. This is especially important in the face of growing MSK inequalities and an aging society working and living longer with MSK conditions.<sup>55</sup> Moreover, there is a need to better understand the development of work-relevant persistent MSK pain in addition to having to deal with its consequences once apparent and affecting the employee. Early MSK-focused intervention, which does not rely on services provided by the NHS in the UK, is an area in which employers may play a role, potentially facilitating timely resolution and helping prevent workplace injury and ill-health retirement. An example is empowering line managers to recognize and accommodate workers who are struggling to maintain work ability in the face of work-relevant symptoms.<sup>59</sup> Education programs may be needed to help managers recognize the early signs of MSK conditions, aiding referral to OH. As employees with MSK conditions are likely to have comorbidities, keeping them in work is likely to require a holistic approach and supportive measures. For employees who have been absent from work, rehabilitation services and gradual return to work programs will be needed. Pain has also been shown to be associated with adverse employment and financial outcomes for cancer survivors in a survey of 1213 adults diagnosed with cancer.<sup>60</sup> In that study, severe pain was associated with employed patients changing to part-time work or less demanding jobs, and was strongly associated with early retirement. Similar recommendations were made following that study, namely the requirement for better assessment and management of pain, and future research should aim to develop and test



interventions for effective pain management that address effects on employment.<sup>60</sup>

In summary, this study has shown that Rolls-Royce employees with work-relevant persistent MSK pain took significantly more sickness absence days compared with age-, sex-, and job role-matched controls across all time periods assessed, resulting in higher costs to Rolls-Royce. Furthermore, MSK-related absences accounted for 47% of all sickness absence. These unique data, obtained from HR, OH, and safety systems, provide evidence of the burden placed on employers by work-relevant persistent MSK pain, despite the workforce and management having access to comprehensive OH services. Knowledge gaps remain that will be addressed by further focused studies, such as a follow-up cross-sectional study evaluating work productivity in Rolls-Royce employees. Integration of multiple relevant data sources as described in this report is recommended as a means of obtaining a true picture of employee health and its impacts. Employers may benefit from exploring additional workplace/supportive interventions focused on the idea of providing good jobs and an accommodating workplace to improve workers' health and well-being. It would be helpful to understand the optimal approach to address lifestyle factors, specifically diet and movement, that are potentially modifiable and how these may be targeted, thereby lessening the impact of work-relevant persistent MSK pain and, ultimately, reducing the cost of sickness absences.

## ACKNOWLEDGMENTS

The authors thank the STAMPP (Societal Impact Persistent Pain) steering group (Ian Brown, Hamish Laing, Ann Taylor, Owen Hughes, and Mansel Aylward) for their expert guidance and Birol Emir (Pfizer Inc., USA) and Kieran Hart (Adelphi Real World) for contributions to the study design and data interpretation.

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