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Sickness absences and losses in productivity-adjusted life years before, during and after the most common orthopedic surgical procedures among employed individuals in Finland

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Abstract

Background Musculoskeletal diseases requiring surgical procedures in working-age adults impose a significant financial burden on many societies. This observational study focused on evaluating the seven most common elective orthopedic surgeries among the Finnish working-age employed population with an aim to assess the extent of sickness absence accumulation before and after the surgical procedure, along with the duration of hospital stay during treatment. Additionally, the study aimed to quantify productivity-adjusted life years (PALY) and assess the societal economic impact of PALY loss due to sickness absence.

Methods Data from electronic health records from the Wellbeing Services County of Southwest Finland, Finland, in 2020–2022, compiled with information from national administrative registries, were used to identify working-age, employed patients from seven disease groups ($N=770$). Lengths of pre- and post-operative sickness absences together with in-hospital days were calculated, and PALY were estimated over the corresponding periods. Point estimate of the productivity cost of PALY losses was calculated in total and on a per-patient basis based on a reported national average value of one sickness absence day (€344).

Results The average hospital stay across all patient groups ranged from 1.0 to 5.5 days. The longest pre-operative sickness absence was in lumbar spine fusion (36.7 days), and the shortest in patients with knee ligament injuries (4.3 days). The longest post-operative average sickness absence was for shoulder procedures (114.0 days), and the shortest for carpal tunnel syndrome patients (37.2 days). In all seven patient groups together, on average, 17.4 PALY (27.5%

The article provides registry-based data on the accumulation of sickness absences before and after seven orthopedic surgical procedures, as well as the length of hospital stay during the procedure, common among working-age population in the Wellbeing Services County of Southwest Finland. The results are used to estimate productivity losses based on productivity-adjusted life years (PALY) and to quantify these losses in monetary terms.

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of total PALY loss) were annually lost (corresponding to €2,192,683) in the year before hospitalization, 1.0 (1.6%) PALY annually lost (€194,773) during the hospitalization, and 44.8 (70.9%) PALY annually lost (€5,619,243) in the year after hospitalization. The highest pre-operative per-patient PALY loss in monetary terms was among patients with lumbar spine fusion (€16,693), while the highest post-operative per-patient PALY loss in monetary terms occurred among patients with knee osteoarthritis and knee replacement (€28,673).

Conclusions The sickness absences were typically longer and PALY losses in monetary terms per patient were higher in the post-operative period compared to the pre-operative period. The seven patient groups examined produced considerable PALY losses and related total productivity costs to the Wellbeing Services County of Southwest Finland. The results of the study call for actions to support a more rapid return to work.

Keywords Productivity-adjusted life years (PALY), Workforce productivity loss, Return-to-work strategies

Background

Work absenteeism due to illness incurs significant economic challenges worldwide [1, 2]. In 2014, the national economic loss in Finland due to sickness absence was approximately €3.4 billion [3], and by 2022, this figure had risen to €4.1 billion [4]. This indicates an increase in the economic impact of sickness absence over recent years. The most common causes of sickness absence are mental and behavioral disorders and musculoskeletal diseases in Finland [5], which also accounted for two thirds of the reasons for disability retirement in 2022 [6].

Prolonged waiting times before hospitalization can extend sickness absence, delay the start of medical treatment, and potentially worsen the patient's condition and quality of life [7, 8]. Delays in elective surgeries, for example, have been linked to extended work absences and increased healthcare costs due to deteriorating health [7]. Longer hospital stays can lead to extended work absences, particularly for conditions requiring inpatient care. Efficient hospital management, such as early discharge programs and enhanced recovery after surgery protocols, can help reduce hospitalization durations, leading to faster reintegration into the workforce [9]. The length of post-operative recovery significantly affects the duration of sickness absence. Structured rehabilitation programs and outpatient follow-ups play a crucial role in ensuring timely recovery and return to work [10].

Optimizing pre-hospitalization waiting periods, hospital treatment durations, and post-operative recovery protocols are essential for bolstering health security, which is closely linked to the ABC framework of sickness absence [11]. By analyzing sickness absence during the pre-operative waiting period (A), medical treatment duration in hospital (B), and post-operative recovery, i.e., sickness absence and/or disability following hospitalization (C) [11] through the lens of health security, we can better understand the systemic challenges and develop strategies to improve healthcare resilience and workforce productivity.

This concept is currently being developed and integrated into the productivity-adjusted life years (PALY) framework. PALY is a newly developed health metric [12] designed to measure the societal impact of ill health. Typically, PALY is calculated by multiplying a productivity index (PI), which ranges from 0 (no productivity) to 1 (full productivity), by the number of years lived. This metric has been utilized to assess a variety of health conditions in both high- and low-income countries, see for example [13–18]. Most of the existing research on PALY relies on life tables and dynamic modeling to estimate the impact of disease on productivity throughout an individual's working life. We have previously assessed the burden of eight chronic conditions on annual PALY in both the employed and general Finnish populations, and found musculoskeletal diseases to associate with the second-highest PALY losses, after depression and other mental health problems [18].

This study aimed to describe ABC times in the most common elective orthopedic surgical procedures and, using registry data, to assess the burden of the underlying diseases on PALY across the different phases of the ABC care pathway in these patient groups. In register-based research, the focus can only be on absenteeism, as sources of presenteeism are not available through registry data. In this study, one PALY represents one year spent in perfect work ability, while sickness absence reduces the PI and, consequently, the accumulation of PALY for the patient group being studied.

Methods

Setting

Finland has a comprehensive social insurance system that provides financial security and social welfare services for all residents [19]. The distinctive features of the Finnish social insurance system are outlined in Additional file 1, given their substantial influence on the study design.

Data collection

This study utilized a cohort of all patients undergoing the most common elective orthopedic surgical procedures operated at Turku University Hospital, who could be reliably monitored based on their diagnoses. Our focus was on analyzing the services offered within the public healthcare system. The clinical patient data were collected from the electronic health records (EHR) of the Wellbeing Services County of Southwest Finland (approximately 490,500 residents in 2023 [20], equaling to around 9% of the Finnish population). Due to its size as one of the largest of 21 wellbeing services counties in Finland, it is highly representative of Finland's healthcare system. EHR data were used to identify patients from the selected patient groups operated on in 2020–2022. EHR data contained background information on patients, such as age and sex, as well as data on date of surgery, procedure codes, and date of hospital discharge. EHR data were compiled with the data from the National Sickness Benefits Register and the Retirement Benefits Register maintained by the Social Insurance Institution of Finland for the years 2019–2023. Additionally, we also had access to the Retirement Benefits Register and Earning Register (pension-insured employment) from the Finnish Centre for Pensions for the years 2019–2023 and the outpatient care register (Avo-Hilmo) maintained by the Finnish Institute for Health and Welfare for the years 2019–2023.

Patient population

Patients were identified using the procedure classification maintained by the Finnish Institute for Health and Welfare [21]. The Finnish procedure classification is based on the Nordic Classification of Surgical Procedures (NCSP) [22]. The NCSP classification is maintained by the Nordic Classification Centre, and its copyrights are held by NOMESCO. The selected patient groups were 1) Rotator cuff injury, and repair, 2) Hip osteoarthritis and hip replacement, 3) Knee osteoarthritis and knee replacement, 4) Knee anterior cruciate ligament injury and ligament reconstruction, 5) Carpal tunnel syndrome and carpal release, 6) Lumbar intervertebral disc disease, radicular symptoms and discectomy, and 7) Lumbar spine stenosis/instability and fusion. Patients were identified based on the performed surgical procedures, while diagnoses were used to identify sickness absences. Table 1 presents the procedure codes used in Finland (Table 1). The Finnish version of the NCSP explicitly targets these codes anatomically. For example, coding NAG61 is used for 'fusion for lumbar spine without instrumentation", whereas NAG40 would be "fusion of cervical spine, anterior approach".

Table 1 Patient groups and surgical procedures used to identify patients included in the study

Patient groups	Procedure codes (NCSP)
Rotator cuff injury, and repair	NBL00, NBL05
Hip osteoarthritis and hip replacement	NFB30, NFB40, NFB50
Knee osteoarthritis and knee replacement	NGB10, NGB20, NGB40
Knee anterior cruciate ligament injury and ligament reconstruction	NGE35
Carpal tunnel syndrome and carpal release	ACC51
Lumbar intervertebral disc disease, radicular symptoms and discectomy	ABC16, ABC17, ABC26, ABC36, ABC56
Lumbar spine stenosis/instability and fusion	NAG61, NAG62, NAG63, NAG66

ICD-10 codes to identify disease-related sickness absence before and after the surgical procedure are presented in Additional files 2 and 3, respectively

Inclusion and exclusion criteria

The study included patients of working age (18 to 66 years) who were actively employed. Old-age and full disability retirees and adults outside the labor force were excluded. Thus, individuals on partial retirement pension, surviving spouse's pension, or similar benefits were not excluded. Retirement status was determined using registry data, based on which a patient was considered retired if the patient was receiving retirement benefits on the date of surgery. Employment status was identified using the earnings register of the Finnish Centre for Pensions. Patients were classified as actively employed if the patient had earnings on the date of the surgical procedure.

Ethical approval

By Finnish law, no ethics committee approval was necessary since only anonymized data were utilized, and study participants were not contacted. Thus, no written consent from the patients was required. The Wellbeing Services County of Southwest Finland granted permission for the use of clinical data by its practices and pseudonymized the dataset before delivering it to a secure data repository. The Social Insurance Institution of Finland granted permission to use the National Sickness Benefits Register and the Retirement Benefits Register. All data were anonymized before being provided to the research team. The Finnish Centre for Pensions has also granted permission to the research team to use the Benefits Register and the Earning Register. Additionally, the Wellbeing Services County of Southwest Finland, being part of the research team, has permitted to use EHR data. The data had been anonymized and pseudonymized in advance by the authorities by Finnish national regulations and laws, and we merged the different registry data based on identification numbers. The data could only be accessed in the secure operating environment (Auria's Atolli) managed by the Wellbeing Services County of Southwest Finland [23]. Researchers who had access to this secure environment were provided with the appropriate identification and login credentials. The study complies with the Declaration of Helsinki.

ABC times

We defined the ABC times as follows:

1) Length of the sickness absence before the surgical procedure, i.e., the pre-operative period A, was determined by identifying sickness absence periods from the Finnish Social Insurance Institution's National Sickness Benefits Register and disability periods recorded in the outpatient care register (Avo-Hilmo) based on relevant diagnoses (Additional file 1) at the first visit, before the surgery date.
2) The length of the hospital stay due to the surgical procedure, i.e., treatment period B, was calculated based on the duration of the treatment episode in calendar days recorded in the EHR. This variable was internally defined by the hospital based on the admission and discharge dates.
3) Length of the sickness absence following the surgical procedure, i.e., the post-operative period C, was determined by identifying the sickness absence periods after discharge from the hospital, based on the relevant diagnoses (Additional file 2) after the operation from the Finnish Social Insurance Institution's National Sickness Benefits Register and disability periods recorded in in the outpatient-care register (Avo-Hilmo).

Calendar days of sickness absence were obtained by combining information from the National Sickness Benefits Register and disability periods from the Avo-Hilmo. We defined ABC times as continuous sickness absence before and after the hospital care. However, ABC times within one year before and after the hospital care were needed later in PALY calculations to calculate a PI.

Consecutive sickness absence periods were merged, allowing for a maximum gap of 15 days [24]. Additionally, a maximum gap of 15 days was allowed between the hospital discharge day and the sickness absence period. An additional 10 calendar days were systematically added to all sickness absences recorded in the National Sickness Benefits Register (see Additional file 1).

Mean A and C times were calculated both for disease-related sickness absence, which was determined based on the diagnosis related to the procedure using a Finnish version of the global International Classification of Diseases 10th version (ICD-10) [25] diagnosis classification system (Additional files 2 and 3), and for overall sickness absence, which includes all sickness absences regardless of the underlying diagnosis. If sickness absences were not found in the registers, the length of sickness absence was set to zero.

Formation of PALYs

In this study, the PIs were calculated based on the inverse of the ratio of the total number of sickness absence days to the total number of calendar days during the period, i.e.,

$$PI = 1 - \frac{number\ of\ sickness\ absence\ days}{calendar\ days} \quad (1)$$

For pre-operative period A and post-operative period C, the PIs were limited to one year before and one year after hospitalization, respectively. Accordingly, the denominator in Eq. 1 was set to 365.25, representing the total number of days in year. The PI equals zero during in-hospital period B as patients are not engaged in work during this time. Consequently, the numerator and denominator in Eq. 1 are identical in period B, since all in-hospital days are considered sickness absence days. Non-parametric 95% confidence intervals were generated for the PIs in periods A and C with 1000 bootstrap samples with replacement for each patient group.

Once the PIs had been determined for ABC periods, registry-based PALY for one-year periods A and C were calculated by multiplying the number of patients in each patient group by the PI of that group. PALY in period B was 0 for all patients as they were assumed to be in a hospital instead of working for the whole period. Thereafter, registry-based PALY losses for periods A and C were calculated by subtracting the PALY from the number of patients in the patient group (i.e., assumption of one-year full productivity). For period B, the PALY loss is consistent with the total duration of period B, with the assumption that the days in hospital care are workdays. PALY losses were calculated for (1) 100 patients per patient group to enable comparison between the patient groups and (2) the patient population operated in the Wellbeing Services County of Southwest Finland in 2020–2022.

Point estimates of total productivity cost of sickness absence for the pre- and post-operative year, i.e., periods A and C, were calculated by multiplying the average length of the sickness absence within period by the hypothetical proportion of workdays within the period (i.e., 21.5 workdays/month multiplied by 12 and divided by 365.25 days equaling to 0.706), the number of patients within the patient group, and the average productivity cost of one sickness absence workday (€344) in Finland in 2022 [4]. The average productivity cost of one sickness absence workday presents the indirect productivity cost of illness related to lost production and is estimated across branches of industry in the private and public sectors. The estimate assumes that the employer does not compensate for the loss, and the work contribution is calculated based on gross value added, considering the labor elasticity of production. The productivity cost of hospital stay in period B was calculated by multiplying the average length of the period by the number of patients and the average value of one sickness absence workday, without the correction for hypothetical proportion of workdays.

Sensitivity analyses

First, a sensitivity analysis against the maximum gap of 15 days between consecutive sickness absence periods was conducted with a one-day allowance to examine its effect on the results of the length of sickness absences. Second, sensitivity analyses against the hypothetical proportion of workdays within the period utilized to calculate productivity cost were conducted by fixing the proportion to (1) 0.650, and (2) 0.750 to reflect the effect of different numbers of working days due to collective-agreement holidays, part-time contracts, sick-leave rights, etc.

All the analyses were carried out using the statistical software R version 4.3.1 [26].

Results

From a total of 3,875 patients, a cohort of 2,627 surgically treated patients across seven patient groups was identified. After applying the exclusion criteria, a total of 770 patients were selected for analysis, focusing on those of working age and actively employed. A flow chart of the study sample formation is presented in Additional file 4.

Background information of the employed working-age patients by disease group is presented in Table 2. Men were overrepresented in rotator cuff injury, and repair procedures, while women had proportionally more carpal tunnel syndrome and carpal release, and lumbar spine stenosis/instability and fusion procedures. Other patient groups were balanced concerning sex.

Table 2 Characteristics of the patient groups at the time of the surgical procedure

Patient group	N	Women (%)	Age, years Mean (SD)	Age, years Median (min–max)
Rotator cuff injury, and repair	55	36.4	55.1 (7.7)	56.8 (20.4–63.8)
Hip osteoarthritis and hip replacement	139	53.2	55.7 (5.9)	57.3 (37.3–63.6)
Knee osteoarthritis and knee replacement	154	57.7	57.1 (4.6)	57.9 (40.5–65.1)
Knee anterior cruciate ligament injury and ligament reconstruction	57	47.4	32.5 (8.8)	32.8 (20.2–53.7)
Carpal tunnel syndrome and carpal release	170	72.1	47.6 (10.7)	50.3 (21.2–63.5)
Lumbar intervertebral disc disease, radicular symptoms and discectomy	174	46.0	44.6 (11.0)	44.4 (18.8–65.9)
Lumbar spine stenosis/instability and fusion	21	61.9	55.2 (7.8)	58.0 (32.0–66.3)

The youngest patients, as measured by median age, were those undergoing knee anterior cruciate ligament injury and ligament reconstruction surgical procedures, while the oldest were those undergoing knee osteoarthritis and knee replacement surgical procedures (Table 2). One of the 770 patients died during the year following discharge.

ABC times

The average time of a hospital stay, time B, ranged from 1.0 to 5.5 days across all patient groups (Fig. 1A, Additional file 5). The greatest standard deviation was observed in knee osteoarthritis and knee replacement procedures, with 1.7 days. There was also the greatest range between the minimum and maximum values, from 1 to 17, whereas the ranges in other patient groups were more moderate. In other patient groups, the variation was less pronounced. The longest hospital stay was observed in patients with lumbar spine stenosis/instability and fusion, with an average of 5.5 days.

The length of pre-operative sickness absences, time A, attributed to the condition related to the procedure was the longest in patients with lumbar spine stenosis/instability and fusion, averaging 28.2 days (Fig. 1A, Additional file 5). Post-operative sickness absence, time C due to the procedure-related condition was the longest in knee osteoarthritis and knee replacement patients, averaging 94.9 days.

The length of the overall pre-operative sickness absence, time A, was the longest in patients who underwent lumbar spine stenosis/instability and fusion, with 36.7 days of sickness absence before the hospital stay (Fig. 1B, Additional file 6). The shortest overall time A was observed in patients with knee anterior cruciate ligament injury and ligament reconstruction, with 4.3 days of sickness absence. The post-operative sickness absence time C was the longest for rotator cuff injury, and repair procedures, with 114.0 days.

PALY losses and productivity costs between patient groups in general

The ABC times within one year before and one year after the surgical procedure are shown in Additional file 7. Generally, the PIs were higher in the year before the procedure (period A) than in the year after it (period C). The greatest decrease in the PI was observed after rotator cuff injury, and repair. The lowest PI before the procedure was 0.81 for patients undergoing lumbar spine stenosis/instability and fusion, while the lowest post-operative PI was 0.69 for patients who had rotator cuff injury, and repair. In the other patient groups, the PIs ranged from 0.89 to 0.95 before the procedure and from 0.70 to 0.82 after the procedure (Table 3).

The highest pre-operative PALY losses per 100 patients and associated total productivity cost of sickness absence

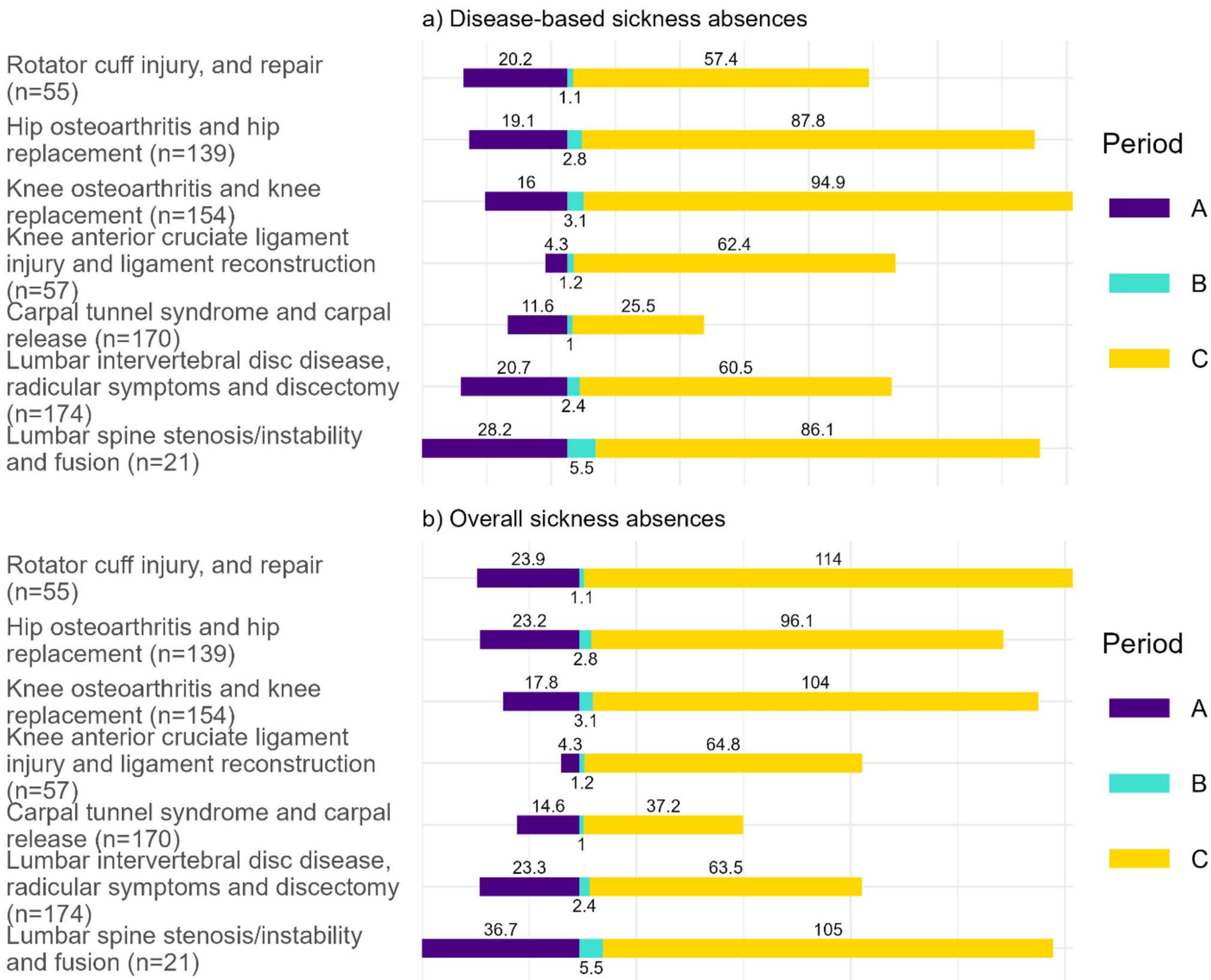

Fig. 1 Average lengths of the ABC periods in days for employed individuals. Pre-operative period A, in-hospital period B, post-operative period C. **a**) Disease-based sickness absences (encompassing sickness absence attributed to the diagnosed condition being studied). **b**) Overall sickness absences (including all causes of sickness absence)

Table 3 The average productivity indices (PIs) by patient group for working age employed individuals

Patient group	Period A (the year preceding the surgical procedure) PI (95% CI)	Period B (during the hospital stay) PI	Period C (the year following discharge) PI (95% CI)
Rotator cuff injury, and repair	0.92 (0.89–0.94)	0	0.69 (0.64–0.74)
Hip osteoarthritis and hip replacement	0.90 (0.86–0.93)	0	0.71 (0.68–0.74)
Knee osteoarthritis and knee replacement	0.91 (0.89–0.93)	0	0.68 (0.65–0.71)
Knee anterior cruciate ligament injury and ligament reconstruction	0.95 (0.92–0.97)	0	0.81 (0.77–0.85)
Carpal tunnel syndrome and carpal release	0.89 (0.87–0.91)	0	0.82 (0.79–0.85)
Lumbar intervertebral disc disease, radicular symptoms and discectomy	0.90 (0.88–0.92)	0	0.80 (0.76–0.82)
Lumbar spine stenosis/instability and fusion	0.81 (0.70–0.90)	0	0.70 (0.61–0.77)

in period A occurred in patients with lumbar spine stenosis/instability and fusion (18.6 lost PALY, €1,669,300) followed by patients with carpal tunnel syndrome and carpal release (10.5 lost PALY, €945,200) and hip osteoarthritis and hip replacement surgical procedure (10.1 lost PALY, €906,400) (Fig. 2 for PALY losses and Table 4 for productivity costs per patient). The highest PALY losses per 100 patients and total productivity cost during the hospital stay in period B occurred in patients with lumbar spine stenosis/instability and fusion, followed by patients

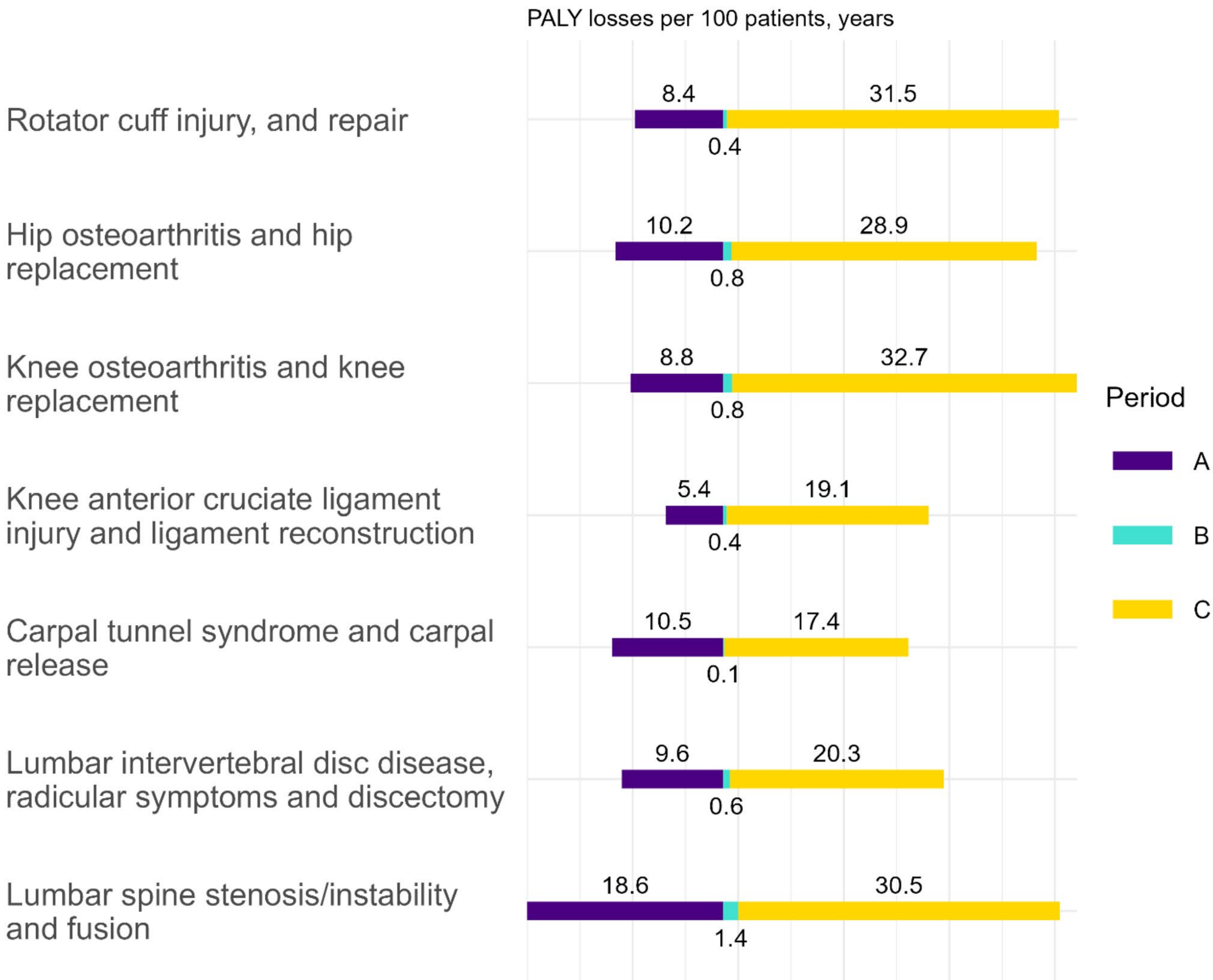

Fig. 2 The PALY (Productivity-Adjusted Life Years) losses per 100 employed patients in years by disease group. Period A, the year preceding the surgical procedure. Period B, during the hospital stay. Period C, the year following discharge

Table 4 Point estimates of the productivity cost of sickness absence per patient by patient groups and periods ABC

Patient group	Total productivity cost over periods ABC, €	Period A (the year preceding the surgical procedure), € (%)	Period B (during the hospital stay), € (%)	Period C (the year following discharge), € (%)
Rotator cuff injury, and repair	35,807	7484 (20.9)	378 (1.1)	27,945 (78.0)
Hip osteoarthritis and hip replacement	35,784	9064 (25.3)	963 (2.7)	25,757 (72.0)
Knee osteoarthritis and knee replacement	37,417	7678 (20.5)	1066 (2.8)	28,673 (76.6)
Knee anterior cruciate ligament injury and ligament reconstruction	22,233	4884 (22.0)	413 (1.9)	16,936 (76.2)
Carpal tunnel syndrome and carpal release	25,445	9452 (37.1)	344 (1.4)	15,649 (61.5)
Lumbar intervertebral disc disease, radicular symptoms and discectomy	27,385	8553 (31.2)	826 (3.0)	18,006 (65.8)
Lumbar spine stenosis/instability and fusion	45,557	16,693 (36.6)	1892 (4.2)	26,972 (59.2)

with hip and knee osteoarthritis and replacement. Generally, the PALY losses during hospital stays were minimal in all patient groups, ranging from 0.1 to 1.0 years. However, the PALY losses per 100 patients after hospital stay in period C were substantial in the year following the procedure. The highest PALY loss and associated total productivity cost occurred after knee osteoarthritis and knee replacement surgical procedure, with a loss of 32.2 years and productivity cost of €2,867,300, followed by rotator cuff injury, and repair, 31.5 years and €2,794,500, respectively. The lowest PALY losses and the following total productivity cost after the surgical procedure in period C occurred among carpal tunnel syndrome and carpal release patients (17.4 lost PALY, €1,564,900).

PALY losses and productivity costs in the Wellbeing Services County of Southwest Finland

PALYs accumulated during the follow-up within the observed patient groups are shown in Additional file 8. Among the patients awaiting hip and knee joint replacement procedures in the Wellbeing Services County of Southwest Finland ($n = 293$), a total of 27.7 PALY was lost in the year preceding the surgical procedure (Additional file 9). In the same group, the time spent in hospital due to the surgical procedure consumed 2.4 PALY, while the post-surgical procedure one-year recovery period consumed 90.5 PALY. In all seven patient groups together, which were operated on in 2020–2022 ($n = 770$), the corresponding figures were 74.1 PALY lost in the year before hospitalization, 4.4 during hospitalization, and 190.4 within the one-year recovery period after hospitalization. The corresponding productivity cost was €6,578,048 in the year before hospitalization, €584,319 during the hospitalization, and €16,857,729 in the year after hospitalization, making altogether €24,020,096 over the ABC periods (Additional file 10). Based on these, the average annual PALY lost in all patient groups together were 24.7 (27.5% of total PALY losses over the period ABC) PALY (corresponding to €2,192,683) in period A, 1.5 (1.6%) PALY (€194,773) in period B, and 63.5 (70.9%) PALY (€5,619,243) in period C making it altogether €8,006,699 over the ABC periods per year.

Sensitivity analyses

Results of the sensitivity analyses against the 15-day gap are presented in Additional files 11 and 12 for condition-related and overall sickness absences, respectively, and showed comparable results. Sensitivity analyses utilizing lower and higher fractions for the theoretical proportion of workdays introduced variation to the results (Additional files 13 and 14).

Discussion

The principal finding of this study was that across all seven patient groups, the number of sickness absence days accumulated both prior to and following hospitalization varied somewhat depending on the patient group. The majority of PALYs lost over the periods ABC were attributable to post-procedural recovery and illness. It is noteworthy, however, that approximately one-quarter of the total PALY losses had already accumulated before the surgical procedures.

Of the examined patient groups, lumbar spine stenosis/instability and fusion patients had the longest disease-related sickness absence in pre-operative period A and hospital stay period B, but the longest disease-related sickness absence in post-operative period C occurred among knee osteoarthritis and knee replacement patients. Accordingly, the PALY losses per 100 patients and the associated total productivity costs within the year preceding the surgical procedure and during the hospital stay were the highest for patients with lumbar spine stenosis/instability and fusion. In addition, the highest PALY losses and productivity costs within the year following hospital discharge were observed among the knee osteoarthritis and knee replacement patients. However, when considering the Wellbeing Services County of Southwest Finland specifically, the highest PALY losses and consecutive productivity costs in periods ABC were among patients with knee osteoarthritis and knee replacement, followed by patients with hip osteoarthritis and hip replacement.

The ABC times can be effectively monitored using registry-based data. In practice, there is no need to intervene in the lengths of periods B in the studied region, as they appear to operate at an efficient level of health production. Periods A, however, can be optimized by investigating and adjusting queuing practices, as well as removing other "bottlenecks" and delays in accessing care. Supportive physiotherapy could be offered to prevent further worsening of the patient's condition. Periods C can be addressed, for instance, by utilizing the nationally implemented and studied Coordinated Return to Work model [24, 27]. The model has been gradually implemented after 2017 to cover the whole country, at least in one patient group per wellbeing services county. In this model, a standardized maximum duration for sickness absence is set by hospital surgeons, after which the patient is referred to occupational health services for an assessment by work ability professionals. In the Wellbeing Services County of Southwest Finland, the results of the Coordinated Return to Work model are not yet visible in the studied patient groups, as the implementation of the model is still ongoing in the area.

The lengths of periods ABC have been examined in several previous studies [28–30], but most studies have examined return to work times, i.e., the length of period C. However, comparison of our results with the previous ones is complicated by the different definitions for patient groups and calendar times of measurement. For example, the lengths of periods ABC among lumbar discectomy patients were 62.8, 2.4, and 82.5 days in Finland in 2013, respectively [28]. Similarly, the corresponding times were 62.8, 2.4, and 82.5 days after knee arthroplasty and 99.6, 3.7, and 119.4 days after hip arthroplasty, respectively. In another study, the length of period C was 116 days after knee arthroplasty and 103 days after total hip arthroplasty in Finland in 1999–2011 [29, 30].

After the Coordinated Return to Work model, the sickness absences after surgeries have shortened [24, 31]. The length of period C was 87 days after total knee arthroplasty and 68 days after primary hip arthroplasty in 2020–2021 in the wellbeing services counties that had implemented the Coordinated Return to Work model [31]. In that study, the patient groups were defined similarly than those in our study, but the lengths of post-operative sickness absences were longer in our study because the Coordinated Return to Work model was not in effect in the Wellbeing Services County of Southwest Finland in the examined patient groups during our study. To note, our study coincided with the COVID-19 pandemic. A recent study conducted in the municipal sector in Finland reported a growth peak in the sickness absences at the time of the pandemic, but thereafter, they have shortened and were lower than ever during the 25-year follow-up in 2024 [32]. In this regard, sickness absences due to the COVID-19 pandemic may have affected our results in a similar manner. Also changes in the volume of primary orthopedic surgeries were observed during the pandemic (see Additional File 15). A noticeable decline in hip and knee surgeries among working-age patients occurred in 2020, but the numbers recovered quickly [33]. When examining the years 2020–2022, the total number of operations was roughly comparable to the levels seen in 2017–2019. However, we were unable to find similar data for working-age patients in other patient groups.

To our knowledge, this is the first study that examines PALYs within the ABC concept. Although ABC periods describe the average length of sickness absence due to a surgical procedure and within periods before and after it, PALY puts them into a societal context by considering the size of the patient groups and the following losses in productivity. As we have shown in this study, the length of sickness absence and its impact on the rising societal costs can be monitored using registry-based PALY. Through PALY, decision-making can be supported by identifying patient groups and periods in patient journeys to which resources should be allocated. Additionally, utilizing the PALY concept in a registry-based framework enables peer benchmarking across different regions from a new perspective. The concept also provides a comprehensive tool for evaluating the total PALY loss in monetary terms incurred by healthcare activities. According to our results and from the perspective of society, the productivity cost of waiting for treatment is high, but it is several times higher after the procedure. Even a small reduction in post-operative recovery time can have positive effects on the national economy. In Sweden's Region Stockholm, for example, performance-based reimbursement models have been implemented in musculoskeletal care [34]. This creates a meaningful incentive structure that aligns clinical decision-making with patient-relevant outcomes and broader societal value.

There are no previous studies that have examined PALY losses in the studied patient groups, except one Australian study on working-age knee osteoarthritis patients [17] and our previous study on annual PALY loss due to musculoskeletal diseases in Finland [18]. In the Australian study, a PI of 0.67 was reported for people with knee osteoarthritis. In comparison, our study revealed a PI of 0.90 within one year before the surgical procedure (period A) and a PI of 0.68 one year after the surgical procedure (period C). The previous Finnish study evaluated PI of musculoskeletal diseases generally with PIs of 0.698 and 0.678 for 18–34-year-old males and females, and 0.789 and 0.771 for 36–64-year-old males and females, respectively. The PIs calculated in the previous Australian and Finnish studies accounted for both absenteeism and presenteeism through the Work Productivity and Activity Impairment questionnaire, while our study utilized registry-based data on absenteeism and could not account for presenteeism. More studies are needed on the development of PI over the years after the surgical procedure. For example, the gain of the surgical procedure may become apparent as late as one to two years after the procedure. To note, a disease does not always lead to a sickness absence. Rather, the need for sickness absence is dependent on the demands of work and work tasks in addition to the individual's health impairment. Thus, more studies on PALY losses by occupational classes are also needed to obtain more targeted insights into return-to-work strategies and the broader economic implications across different workforce segments.

The annual total productivity cost of sickness absence in the examined, most common elective orthopedic surgeries in the Wellbeing Services County of Southwest Finland was €8 million, covering the periods ABC, including the year before hospitalization, in-hospital period, and the year after hospitalization. Considered at the population-level in Finland, in a cautious scenario analysis simply scaling the region-specific estimate by population size, the annual total productivity cost would be around €89 million in these patient groups. We based our estimates on one of the proposed, most recent estimates for the value of one sickness absence workday in Finland [4]. There are also other estimates available that differ in method of calculation. The two most used methods to estimate the productivity cost of sickness absence days are the human capital approach, which assumes losses continue indefinitely, and the friction cost method, which limits losses to the period needed to find a replacement. However, PALY losses have typically been valued with gross domestic product (GDP) per equivalent full-time worker [12–17]. The estimate we used in our study, €344, is the average value of a sickness absence day calculated for the year 2022. It comprehensively accounts for the specific characteristics of various industries in Finland and, based on these factors, provides the best available estimate of productivity cost for a sickness absence day from a societal perspective. The estimate measures the actual daily productivity loss, avoiding the human capital approach's overestimation over long periods and the friction cost method's restriction to a friction period. It captures both wage costs and broader output losses, using simple data on hours, wages, and a productivity multiplier, making it suitable for assessing impacts at both the organizational and macroeconomic levels. Although income levels, job types, and employment contracts can vary significantly, by using the average estimate, we may have avoided a situation where the patient's illness has affected the development of income level, leading to an assessment of the individual's value in terms of productivity as being lower than average [35].

Strengths of the study include the use of registry-based data to avoid recall bias and the use of data from all patients operated in the area during the study time to avoid selection bias. However, the study also had some limitations. First, our data was limited to one region in Finland, which may limit the generalizability of the findings to the national level or to other countries, where healthcare systems, labor markets, and surgical practices may differ. Second, we limited PALY calculations to fixed periods of one year before and after the hospital stay, in addition to the time in hospital care. However, the sickness absence may be longer than one year, for example, before the surgical procedure due to long waiting times. In a Finnish study, 94% of patients with total hip replacement and around 87% of patients with total knee replacement returned to work within 12 months of the surgical procedure [29, 30]. In our study, around 1.0% of sickness absences in period C were longer than 365 days (see Additional files 5 and 6). Therefore, the true PALY losses may be slightly underestimated in our study, at least in some patient groups. To note, sickness absences over the first 300 working days (6-day week) are covered by the Social Insurance Institution of Finland. Thereafter, a rehabilitation subsidy or disability pension can be applied for if the patient meets the criteria. Because longer than one-year periods are not registered in the national Sickness Benefit register, we were unable to conduct sensitivity analyses towards the time window. This supports our restriction of one-year periods before and after the surgical procedure for PALY calculations. Third, we were not able to account for presenteeism (reduced on-the-job performance) because we utilized only register-based data. Presenteeism has been identified as an essential part of a complete and accurate picture of lost workplace productivity [36], accounting for even 60–80% of lost productivity [37–39]. Thus, exclusion of presenteeism clearly leads to severe underestimation of PALY losses in our study. Fourth, as sickness absences lasting over 10 days are registered in the national Sickness Benefit register, the shorter periods could only be approximated utilizing data from the national Hospital Discharge register (Avo-Hilmo). Thus, our study is likely to miss the shortest sickness absences lasting 1–5 days as only the employee's self-declaration for the employer without a medical certificate is needed in these cases in many workplaces. For longer sickness absences, the employer requires a medical certificate. In addition, short sickness absences lasting a maximum of 10 days prescribed in the private sector, including occupational health care, were not captured by the registers used. In municipal workplaces in Finland, sick leaves shorter than 11 days have been reported to contribute to over half of the total costs related to sickness absence [40]. Furthermore, our study could not account for furloughs, temporary layoffs, or remote work arrangements during the COVID-19 pandemic, which may have influenced the need to apply for formal sickness benefits. For these reasons, the lengths of periods A and C, as well as the associated PALY losses and productivity costs, are likely to be underestimated in our study. Fifth, the study only includes patients operated in public health care, while around 1–65% of procedures in these patient groups were carried out in the private sector in 2022 (see Additional file 16). This also leads to underestimation of the number of patients, PALY losses, as well as productivity costs in the current study. Sixth, patients with carpal tunnel syndrome and carpal release were mostly treated in ambulatory surgery, and the day of operation could not be identified with certainty from the registries. Therefore, the number of carpal tunnel syndrome and carpal release patients and consecutive PALY losses and total productivity costs are underestimated in this study. Seventh, the length of period B may be overestimated as the length includes also weekends, as we were not able to separate hospital weekdays from weekends, when most Finns are not working. Eighth, additional 10 calendar days were added to the start of each sickness absence period although the first 10 days (excluding Sundays and national holidays) are not covered by the SII. For this, lengths of periods A and C may be slightly underestimated. Ninth, although we had partial information on part-time sickness absences, we could not adjust our analysis for it because we did not have information on the proportions of absence, and we combined two partially overlapping data sources with the other data missing this information. In our study, around 9.1% of all sick leaves reported in the Sickness Benefit register were part-time. Thus, we may have slightly overestimated the lengths of periods A and C and PALY losses from this perspective.

Conclusion

The duration of sickness absence in the studied patient groups is relatively long both before and after the procedure. It is recommended that further research be conducted on the formation of pre-operative waiting lists and the factors influencing them, with targeted interventions to address these issues. Additionally, reducing post-operative sickness absence should be prioritized. The novel PALY concept allows for monitoring the productivity cost of sickness absence and can be applied using registry data. Further research is needed to estimate the impact of disease on productivity throughout an individual's working life to evaluate the effects of surgical procedures over a longer recovery period.

Abbreviations

EHR	Electronic health records
ICD-10	International Classification of Diseases 10th version
NCSP	Nordic Classification of Surgical Procedures
PALY	Productivity-adjusted life years
PI	Productivity index

Supplementary Information

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Supplementary Material 1: Additional file 1: The Finnish social insurance system. Additional file 2: Relevant ICD-10 codes to identify disease-related sickness absence before the surgical procedure. Additional file 3: Relevant ICD-10 codes to identify disease-related sickness absence after discharge. Additional file 4: Flow chart of the formation of the study sample. Additional file 5: Distributions of disease-specific sickness absences in periods ABC. Additional file 6: Distributions of overall sickness absences in periods ABC. Additional file 7: The length of periods ABC one year before and one year after the surgical procedure by patient group. Additional file 8: Productivity-Adjusted Life Years (PALYs) with 95% confidence intervals (CI). Additional file 9: The Productivity-Adjusted Life Years (PALY) losses in years by disease group in employed individuals over the three-year follow-up. Period A, the year preceding the surgical procedure. Period B, during the hospital stay. Period C, the year following discharge. Additional file 10: Point estimates of total productivity cost of sickness absence by patient groups and periods ABC over the three-year follow-up in the Wellbeing Services County of Southwest Finland. Additional file 11: Distributions of disease-specific sickness absences in periods ABC from **a sensitivity analysis** of replacing the maximum gap between the hospital discharge day and the sickness absence period with one day. Additional file 12: Distributions of overall sickness absences in periods ABC from **a sensitivity analysis** of replacing the maximum gap between the hospital discharge day and the sickness absence period with one day. Additional file 13: Point estimates of productivity costs of sickness absence by patient groups and periods ABC over the three-year follow-up from **a sensitivity analysis** restricting the hypothetical proportion of workdays in the period to 0.650. Additional file 14: Point estimates of productivity costs of sickness absence by patient groups and periods ABC over the three-year follow-up from **a sensitivity analysis** restricting the hypothetical proportion of workdays in the period to 0.750. Additional File 15: Surgery volumes in primary orthopedic surgeries conducted in public sector among working age patients (<65 years old) in Finland during 2017–2022. Additional file 16: Numbers of operations performed in public and private sectors by patient groups in Finland in 2022

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Author contributions

JM and VÄ obtained funding for the study. JH, PL and JM designed the study. PL and AVL analyzed the data. JH, JK, PL, and AVL interpreted the data. JH and PL drafted the manuscript. All authors read and approved the final manuscript.

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Data availability

Access to data is regulated by the European Union General Data Protection Regulations (GDPR) and Finnish laws and therefore, sharing of sensitive data is not possible and data are not publicly available. The data that support the findings of this study are available from the Wellbeing Services County of Southwest Finland, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. An anonymized version of the data is available for researchers who meet the criteria as required by the European Union and Finnish laws for access to confidential data with a data permit of an appropriate authority. Contact information: the Wellbeing Services County of Southwest Finland ([tutkimuksentietopalvelut@varha.fi](mailto: tutkimuksentietopalvelut@varha.fi)), Social Insurance Institute of Finland ([tietoaineistot@kela.fi](mailto: tietoaineistot@kela.fi)), Finnish Centre for Pensions ([aineistotilaukset@etk.fi](mailto: aineistotilaukset@etk.fi)) and Finnish Institute for Health and Welfare ([avohilmo@thl.fi](mailto: avohilmo@thl.fi)).

Declarations

Ethics approval and consent to participate

In accordance with Finnish law, no ethics committee approval was necessary since only anonymized data were utilized, and study participants were not contacted [41]. Thus, no written consent from the patients was required. The Wellbeing Services County of Southwest Finland granted permission for the use of clinical data in accordance with its own practices and pseudonymized the dataset before delivering it to a secure data repository. The Social Insurance Institution of Finland granted permission to use the National Sickness Benefits Register and the Retirement Benefits Register. All data were anonymized prior to being provided to the research team. The Finnish Centre for Pensions also granted permission to the research team to use the Benefits Register and the Earning Register. Additionally, the Wellbeing Services County of Southwest Finland, being part of the research team, has given permission to use EHR data. The data had been anonymized and pseudonymized in advance by the authorities in accordance with Finnish national regulations and laws, and we merged the different registry data based on identification numbers. The data could only be accessed in the secure operating environment (Auria's Atolli) managed by the Wellbeing Services County of Southwest Finland. Researchers who had access to this secure environment were provided with the appropriate identification and login credentials. The study complies with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

J.M. is a founding partner of ESiOR Oy. This company was not involved in carrying out this research. J.H., J.K., P.L., A-V.L., Z.A. and V.Ä. declare no conflicts of interest.

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