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ORIGINAL ARTICLE

The influence of socio-demographic and clinical factors on sick leave and return to work after open-heart surgery: a nationwide registry-based cohort study

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Aims To estimate sick leave (SL) duration after first-time elective open-heart surgery and identify factors contributing to increased SL.

Methods and results A retrospective nationwide cohort study combined data from the Norwegian Register for Cardiac Surgery and SL data from the Norwegian Labour and Welfare Administrations. All able-bodied adults who underwent first-time elective open-heart surgery in Norway between 2012 and 2021 were followed until 1 year after surgery. The impact of socio-demographic and clinical factors on SL after surgery was analysed using logistic regression and odds ratios. Of 5456 patients, 1643 (30.1%), 1798 (33.0%), 971 (17.8%), 1035 (18.9%), and 9 (0.2%) had SL of <3, 3–6, 6–9, and 9–12 months, and 1 year, respectively. SL >6 months was associated with female gender, primary education only, and average annual income. Post-operative stroke, post-operative renal failure, New York Heart Association Functional Classification system (NYHA) score >3, earlier myocardial infarction, and diabetes mellitus increased the odds of SL >6 months.

Conclusion This study demonstrates that socio-demographic and clinical factors impact SL after first-time elective open-heart surgery. Patients who experience a stroke or develop renal failure after surgery have the highest odds of SL >6 months. Females and patients with low education levels, earlier myocardial infarction, or NYHA scores III–IV have a two-fold chance of SL >6 months. The findings allow for future investigations of pre- and post-surgery interventions that can most effectively reduce SL and aid return to work.

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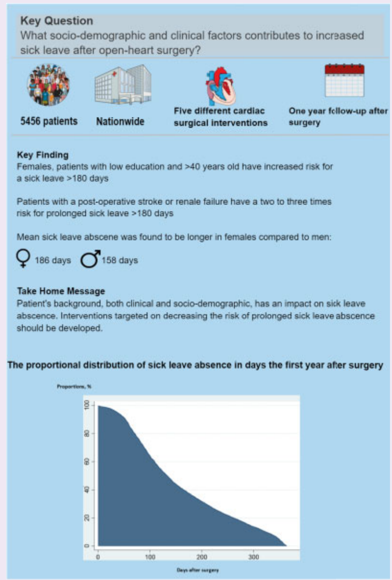
Graphical Abstract



Keywords Cardiac surgery • Cohort • Nationwide • Registry study • Registry-based cohort study • Sick leave

Key Learning Points

What is already known?

- Cardiovascular diseases are the cause of 20% of all deaths in Europe.
- After cardiac surgery, all patients are expected to be on sick leave (SL) and undergo rehabilitation.
- Return to work after cardiac surgery can be troublesome for patients and highly affect the quality of life.

What this study adds?

- The patient's socio-demographic and clinical background is crucial in determining the duration of SL following cardiac surgery.
- Clinical factors associated with extended SL of over 6 months are cerebral stroke, kidney failure, previous heart attacks, and diabetes.
- There is a stark difference in prolonged SL risk between genders. Women demonstrate approximately twice the risk compared to men.

Introduction

Cardiac surgery is a complex and often life-saving procedure, and more than a million patients annually undergo cardiac surgery worldwide.[1] In the active working-age group, coronary artery bypass grafting surgery (CABG) and aortic valve replacement (AVR) are the most frequent procedures.[2] Although the results with regard to survival and severe complications after surgery are generally very good,[3] patients' ability to return to work (RTW) and reducing factors that increase sick leave (SL) should be given more attention.

After hospital discharge, all patients are expected to have a period of SL and rehabilitation due to the cardiovascular disease itself, the general impact of extensive surgery, and the post-operative limitations on patients due to the sternotomy.[4] In a recent review from our research group, it was reported that SL could be as long as 30 weeks for CABG and AVR, making the actual SL duration significantly longer than expected by the patient and the clinician, as patients are generally informed about a 6–8-week SL.[5] Furthermore, socio-demographic and clinical factors have been identified as potential contributors to longer SL durations and decreased ability to RTW. Females and individuals with low primary education and income are reported to have a higher incidence of not returning to work or having longer periods of SL.[6–9] Patients with comorbidities or severely impaired physical capacity are also less likely to RTW.[6,10–12]

In addition to its negative impact on patients' health and quality of life, SL is also a financial burden on society. While RTW should be one of the primary goals of cardiac care after surgery, the existing literature on RTW outcomes after cardiac surgery is limited, with most studies focusing solely on CABG or AVR.[13–16] Hence, little is known about the impact of combined surgical procedures, such as CABG and AVR in addition to ascending aortic surgery (AAS), on work absence.

This study aimed to address this gap in the literature by estimating the SL taken following five categories of first-time open-heart surgery in an active working group of patients and identifying socio-demographic and clinical factors contributing to increased SL. The study findings could help healthcare professionals better understand the factors that impact RTW outcomes after cardiac surgery, which may, in turn, inform the development of more effective interventions to support patients in returning to work and improving their quality of life.

Materials and methods

Setting and patient sample

This nationwide registry-based cohort study merged the Norwegian Register for Cardiac Surgery (NRCS) with the Norwegian Labour and Welfare Administration's (NWLA) administrative database. The NRCS dataset included a total of 9733 individuals who received elective first-time open cardiac surgery in Norway between 1 January 2012 and 22 November 2021. Patients were between 18 and 65 years old at the time of the surgery. A total of 4234 individuals (982 women and 3252 men) were excluded due to lack of employment, working independently, being self-employed, or missing SL information in the NWLA database. Another 43 individuals operated after 22 November 2021 were not included to ensure a 1-year follow-up on SL for all individuals. The final cohort comprised 5456 individuals (770 women and 4686 men) employed prior to surgery (*Table 1*).

Register and database data

The study population was linked to the NRCS and NWLA by the 11-digit national identity number assigned to all Norwegian residents. All patients fulfilling set inclusion criteria were identified in the NRCS. This dataset, containing the time of surgery and reference data, was sent to the NWLA to identify the patients in their database accordingly. A de-identified dataset from the NWLA was sent to the project manager. A statistician then aligned the databases before starting the analysis. The enrolment log and identification were kept at the NWLA.

All patients who undergo cardiac surgery in Norway are registered in the NRCS. The register contains information regarding diagnosis and type of cardiac surgical intervention, demographic data, risk factors, and post-operative complications. The NWLA register includes public information on employment-related matters such as sickness, absence periods, and diagnoses. The register also contains details on work contracts, type of work, annual income, and whether the patient is out of work due to disability or on work assessment allowance (WAA). Demographic data from the NWLA contain information on the region where individuals reside in Norway and the date of eventual death. In Norway, medically certified SL is compensated with 100% coverage for the first 12 months. Hence, the observation time for SL in this study and the databases was set to 12 months. After 12 months of SL, patients can apply for a long-term benefit WAA or disability pension through their general practitioner if they are not ready to reintegrate into employment.

The sample consisted of working adult patients in the age group of 18–65 years who underwent their first-time open-heart surgery within one of the following five categories: (i) CABG, (ii) isolated AVR, (iii) AAS, (iv) a combination of AVR and CABG, or (v) a combination of aorta valve and aorta surgery.

Outcome measures

The outcome in this study was the duration of SL in relation to the surgical intervention and socio-demographic and clinical factors. Patients' SL duration was monitored from the date of their operation until 12 months after surgery. Clinical data and employment status at the time of surgery were obtained. The study cohort was classified according to two cut-off points in the number of days on SL, either >3 or >6 months after their cardiac surgical intervention. These cut-off points were set in relation to clinical data as psychological and physical rehabilitation, including sternal healing, may take more than 3 months. Previous studies have reported that the mean time for patients to RTW after cardiac surgery is often up to 6 months.[5,17]

Clinical data collected from the NRCS were patients' weight, height, ejection fraction (EF), S-creatinine, and creatinine clearance, as well as two clinical scoring systems, the Euroscore 1 (ES1) and the New York Heart Association Functional Classification system (NYHA). Information on patients' comorbidities comprised diabetes mellitus, hypertension, pre- and acute post-renal failure, myocardial infarction (MI) within the last 3 months before surgery, chronic lung disease, endocarditis, arterial disease, and arrhythmias. Post-operative data on incidents of sepsis, stroke, deep surgical wound infection, pre-operative renal failure, and MI were also gathered from the NRCS.

In the NWLA, socio-demographic data were identified, including SL data, type of employment, educational level, region of patients' domicile, and annual income. Annual income was assessed based on the income before taxes and was divided into four categories [<33 000, 33 000–62 000, 62 000–95 000, and >95 000 EURO (EUR); currency converted from Norwegian Kroner (NOK) to EUR on 24 May 2023, using the www.xe.com online converter (1 EUR = 11.8182 NOK)]. Educational levels were categorized according to the Norwegian school system, where primary education lasts 9–10 years, secondary education lasts 3–4 years, and university or college degrees vary from 3 years or more. The geographical regions were classified into five relatively well-defined areas of Norway: north, mid, west, east, and south.

Statistical analyses

To examine the association of clinical and socio-demographic factors (independent variables) with SL (dependent variable), we used logistic regression models. The associations were estimated separately for SL >3 and >6 months and reported as odds ratios (ORs) with 95% confidence intervals. Analyses were performed in both crude form and then with adjustments for the following potential confounding factors: age, gender, comorbidities (diabetes mellitus and hypertension), geographical region, and level of education. Sample characteristics were presented as mean and standard deviation (SD) and interquartile range (IQR), whereas categorical data were analysed using frequencies and percentages. For continuous sample characteristics, means and frequency counts were used. All statistical tests were two-tailed, and *P*-values below 0.05 were considered statistically significant. All analyses were performed using Stata release MP/19 (Stata Corporation LLC, College Station, TX, USA).

Ethical considerations

The study was approved by the Regional Committee for Medical and Health Research Ethics (REK number: 208556) and the Norwegian Centre for Research Data (NSD number: 813388). According to Norwegian regulations, data handled in medical quality registers are excepted from the rule of written informed consent from participants; thus, informed consent was not collected in this study. Specific approval was obtained from the NWLA to release the data from their duty of confidentiality. The General Data Protection Regulations were fulfilled accordingly, and a specific Data Protection Impact Assessment was performed to identify risks in the processing of personal data and to minimize these risks as far and as early as possible.

Results

Study sample characteristics

A total of 5456 patients were identified as eligible between 2012 and 2021 in the NRCS. All patients had employment and SL status information in the NWLA and could be followed for 12 months after surgery. The socio-demographic and clinical characteristics of the patients and their surgical interventions are shown in *Tables 1* and 2, respectively. A total of 770 females (14.1%) and 4686 males (85.9%) were included in this study, with a mean age of 55.4 (SD

Table 1 Study sample characteristics

	All patients	Female	Male
Sex [n (%)]	5456	770 (14.1)	4686 (85.9)
Age (mean, SD[a])	55.4 (7.9)	55.0 (8.9)	55.5 (7.7)
Sick leave absence (mean, SD[a])	161.5 (98.8)	185.5(102.1)	157.6 (97.7)
Geographic region [n (%)]			
West	1708 (31.3)	227 (29.5)	1481 (31.6)
North	558 (10.2)	77 (10.0)	481 (10.3)
East	1999 (36.6)	301 (39.1)	1698 (36.2)
South	196 (3.6)	31 (4.0)	165 (3.5)
Mid	276 (5.1)	40 (5.2)	236 (5.1)
Missing	719 (13.2)	94 (12.2)	625 (13.3)
Income EUR[b] [n (%)]			
<33 000	694 (12.7)	229 (29.7)	465 (9.9)
62 000–33 000	2760 (50.6)	421 (54.7)	2339 (49.9)
95 000–62 000	1098 (20.1)	58 (7.5)	1040 (22.2)
≥95 000	904 (16.6)	62 (8.1)	842 (18.0)
Education [n (%)]			
University/college >3 years	1552 (28.4)	164 (21.3)	1388 (29.6)
University/college 1–3 years	1029 (18.9)	186 (24.2)	843 (18.0)
Secondary education 3 years	2398 (43.9)	336 (43.6)	2062 (44.0)
Primary education 9 years	211 (3.9)	64 (8.3)	147 (3.1)
Missing	266 (4.9)	20 (2.6)	246 (5.3)
Professional categories [n (%)]			
Military	210 (3.9)	20 (2.6)	190 (4,1)
Academics	2876 (52.6)	409 (53.1)	2467 (52.7)
Sales and services	776 (14.2)	256 (33.2)	520 (11.2)
Primary industries	41 (0.8)	4 (0.5)	37 (0.8)
Craftmanship	660 (12.1)	2 (0.3)	658 (14.1)
Machine and transport workers	626 (11.5)	15 (2.0)	611 (13.0)
Occupations with no requirements	211 (3.9)	64 (8.3)	147 (3.1)
Missing	56 (1.0)	—	56 (1.0)
BMI[c] [n (%)]			
Underweight	20 (0.4)	12 (1.6)	8 (0.1)
Normal weight	1115 (20.4)	236 (30.6)	879 (18.8)
Overweight	2041 (37.4)	229 (29.7)	1812 (38.7)
Obese	1173 (21.5)	152 (19.8)	1021 (21.8)
Missing	1107 (20.3)	141 (18.3)	966 (20.6)
Diabetes treatment [n (%)]	701 (12.8)	98 (12.7)	603 (12.9)
Hypertension treatment [n (%)]	2091 (38.3)	272 (35.3)	1819 (38.8)
Lung disease [n (%)]	124 (2.3)	22 (2.9)	102 (2.2)
Arterial disease [n (%)]	117 (2.1)	15 (2.0)	102 (2.2)
Previous heart infarction[d] [n (%)]	326 (6.0)	38 (4.9)	288 (6.2)
Post-operative stroke [n (%)]	37 (0.7)	7 (0.9)	30 (0.7)
Pre-operative renal failure [n (%)]	85 (1.6)	12 (1.7)	73 (1.7)
NYHA-class[e] [n (%)]			
1	569 (10.4)	70 (9.1)	499 (10.7)
2	1992 (36.6)	289 (37.5)	1703 (36.3)
3	2004 (36.7)	295 (38.3)	1709 (36.5)
4	291(5.3)	28 (3.6)	263 (5.6)
Missing	600 (11.0)	88 (11.4)	512 (11.9)

Table 1 Continued

	All patients	Female	Male
Ejection fraction [*n* (%)]			
Normal	1382 (25.3)	214 (27.8)	1168 (24.9)
Reduced	342 (6.3)	26 (3.4)	316 (6.7)
Missing	3732 (68.4)	530 (68.9)	3202 (68.3)
Euroscore 1 [*n* (%)]			
Low risk (0–2)	2021(37.0)	133 (17.3)	1888 (40.3)
Medium risk (3–5)	1028 (18.8)	221 (28.7)	807 (17.2)
High risk (≥6)	129 (2.4)	33 (4.3)	96 (2.1)
Missing	2278 (41.8)	383 (49.7)	1895 (40.4)

[a]Standard deviation.
[b]Euro.
[c]Body mass index.
[d]Three months prior surgery.
[e]New York Heart Association Functional Classification.

7.9) years. CABG was the most frequently performed cardiac operation (58.6%) in males, while isolated aortic valve surgery was the most common intervention (41.8%) in females. The percentage of patients on anti-hypertensive treatment was highest in the combined AVR/CABG group (44.4%). The number of patients on anti-diabetic treatment was highest in the CABG group (18.0%). Across all surgical interventions, most patients in all surgery groups scored II or III on the NYHA classification, except for those having AAS, who had a lower score. Similarly, the majority of patients had a normal pre-operative left ventricular EF. CABG patients had the highest incidence of post-operative stroke (*Tables 1* and *2*).

Pre-operative body mass index (BMI) was found to be above a healthy weight range in both genders, with a mean BMI of 26.9 (SD 5.00) and 28.0 (SD 4.20) in females and males, respectively. When using established categories of BMI, it was observed that 60.6% of female and 76.1% of male patients were overweight or obese (*Table 1*).

The incidence of diabetes mellitus was 12.8%, with no gender difference. Furthermore, one of the most frequently observed post-operative complications was acute renal failure ($n = 85$; 1.6%). The NYHA score was found to be similar between males and females; however, female patients had a higher mean ES1 score compared with males, 3.1 (SD 2.0) vs. 2.0 (SD 1.8), respectively (*Table 1*).

Of the 5456 patients eligible for the study, 1643 (30.1%), 1798 (33.0%), 971 (17.8%), 1035 (18.9%), and 9 (0.2%) had SL of <3, 3–6, 6–9, and 9–12 months, and 1 year, respectively. Females generally had a longer SL duration than males overall and across all interventions. Specifically, the overall mean SL for females was 185.5 days (SD 102.1 days; IQR 97–275) vs. 157.6 days (SD 97.7; IQR 80–226) for males. No significant differences were found in SL among the different cardiac interventions (*Tables 2* and *3*).

Socio-demographic factors related to a prolonged sick leave

Female patients had higher odds of SL >6 months compared with males. Furthermore, patients above 55 years exhibited significantly higher odds for SL >3 months. However, within the group of SL >6 months, there was an observed tendency for patients >55 years to have a decreased OR, although this did not reach statistical significance. Patients with primary or secondary education had higher odds of SL exceeding both 3 and 6 months than those with a university degree. Patients earning <33 000 EUR had lower odds of prolonged SL >3 and >6 months compared with patients with an average Norwegian annual revenue of 33 000–62 000 EUR. Physically demanding jobs (craftsmanship, agriculture, transport workers, and medical care professions) had statistically significantly higher odds of SL >3 and >6 months than jobs that are typically less physically demanding (office work and academic careers) (*Table 4*). The OR of longer SL in relation to patients' work category is shown in *Table 5*.

According to this study, the geographical region where the patient resides is associated with the patient's SL. Patients in Norway's north and eastern regions had higher odds of SL >6 months than the other regions. Compared with the west region, the south and middle regions tended to have higher odds of SL >6 months, although this was not statistically significant (*Table 4*).

Clinical factors related to prolonged sick leave

Patients with pre-operative comorbidities, diabetes mellitus, and previous MI had substantially higher odds of SL >6 months than those without these conditions (*Table 4*). Hypertension was not associated with SL, while chronic lung disease was associated with non-significant odds of SL >6 months. Our study did not find any significant association between BMI and SL. However, a tendency of SL >6 months could be observed in obese patients (*Table 4*).

Patients who suffered from post-operative stroke had three-fold odds of SL >6 months. Moreover, pre-operative acute renal failure significantly doubled the odds of SL >6 months (*Table 4*). Other post-operative complications such as sepsis (0.1%), infections (5.4%), deep surgical wound infection (0.6%), and reoperation due to bleeding (3.1%) were not found to affect SL.

A pre-operative NYHA classification ≥III was associated with significantly higher odds of SL >6 months than lower NYHA scores. Similarly, patients with a reduced EF and those with medium- or high-risk ES1 were associated with higher odds for a longer SL (*Table 6*).

The longest SL for females was observed following AAS, as the odds of SL >3 months were three-fold [OR 3.0 (95% 0.9, 10.8)] and SL >6 months were two-fold [OR 2.5 (95% 1.1, 5.5)] compared with isolated aortic valve surgery. Furthermore, for AAS patients >55 years, the odds of SL >3 months were more than three-fold [OR 3.3 (95% 1.4, 7.5) [0.005]] and SL <6 months were two-fold [OR 2.0 (95%1.1, 3.6) [0.017]]. The longest SL >6 months for males was observed in the combined AVR/CABG surgery group compared with aortic valve surgery alone [OR 1.3 (95% 1.0, 1.8)] (*Table 3*).

Table 2 Sample characteristics by surgical intervention between the years 2012 and 2021 in five Norwegian cardiac surgical centres

Characteristics	CABG[a] (n = 3035)	Valve and CABG[a] (n = 329)	Valve and aorta-surgery (n = 488)	Valve-surgery (n = 1451)	Ascending aorta (n = 153)
Sex (%)					
Male	2744 (90.4)	297 (90.3)	404 (82.8)	1129 (77.8)	112 (73.2)
Female	291 (9.6)	32 (9.7)	84 (17.2)	322 (22.2)	41 (26.8)
Age (mean ± SD)	56.9 (5.9)	58.1 (6.1)	51.4 (10.3)	53.5 (9.6)	52.7 (10.2)
SLA[b] (mean ± SD[c])	163 (100)	166 (99)	156 (97)	157 (96)	174 (102)
Geographic region (%)					
West	1040 (34.3)	98 (29.8)	132 (27.1)	386 (26.6)	52 (34.0)
North	315 (10.3)	39 (11.8)	55 (11.3)	134 (9.2)	15 (9.8)
East	1017 (33.5)	123 (37.4)	190 (38.9)	616 (42.5)	53 (34.7)
South	84 (2.8)	14 (4.3)	25 (5.1)	67 (4.6)	6 (3.9)
Mid	175 (5.8)	8 (2.4)	19 (3.9)	70 (4.8)	4 (2.6)
Missing	404 (13.3)	47 (14.3)	67 (13.7)	178 (12.3)	23 (15.0)
Education (%)					
University/college >3 years	855 (28.2)	85 (25.8)	144 (29.5)	424 (29.2)	44 (28.8)
University/college 1–3 years	556 (18.3)	66 (20.1)	103 (21.1)	324 (18.2)	40 (26.1)
Secondary education 3 years	1363 (44.9)	147 (44.7)	193 (39.6)	636 (43.9)	59 (38.6)
Primary education 10 years	21 (3.7)	8 (2.4)	21 (4.3)	64 (4.4)	6 (3.9)
Missing	27 (4.9)	23 (7.0)	27 (5.5)	63 (4.3)	4 (2.6)
Income EUR[d] (%)					
<33 000	373 (12.3)	41 (12.5)	47 (9.6)	216 (14.9)	17 (11.1)
62 000–33 000	1590 (52.4)	177 (53.8)	223 (45.7)	690 (47.5)	80 (52.3)
95 000–62 000	606 (20.0)	60 (18.2)	115 (23.6)	280 (19.3)	37 (24.2)
≥95 000	466 (15.3)	51 (15.5)	103 (21.1)	265 (18.3)	19 (12.4)
Diabetes treatment (%)					
Yes	545 (18.0)	50 (15.2)	17 (3.5)	85 (5.9)	4 (2.6)
No	2284 (75.2)	254 (77.2)	451 (92.4)	1290 (88.9)	143 (93.5)
Missing	206 (6.8)	25 (7.6)	20 (4.1)	76 (5.2)	6 (3.9)
Hypertension treatment (%)					
Yes	1342 (44.2)	146 (44.4)	133 (27.3)	404 (27.8)	66 (43.1)
No	1430 (47.1)	152 (46.2)	329 (67.4)	970 (66.9)	80 (52.3)
Missing	263 (8.7)	31 (9.4)	26 (5.3)	77 (5.3)	7 (4.6)
Lung disease (%)					
Yes	57 (1.9)	13 (4.0)	5 (1.0)	42 (2.9)	7 (4.6)
No	793 (26.1)	88 (26.7)	198 (40.6)	500 (34.5)	38 (24.8)
Missing	2185 (72.0)	228 (69.3)	285 (58.4)	909 (62.6)	108 (70.6)
Previous heart infarction (%)					
Yes	306 (10.0)	12 (3.7)	2 (0.4)	5 (0.4)	1 (0.6)
No	539 (17.8)	89 (27.1)	203 (41.6)	540 (37.2)	44 (28.8)
Missing	2190 (72.2)	228 (69.3)	283 (58.0)	906 (62.4)	108 (70.6)
Arterial disease (%)					
Yes	55 (1.8)	9 (2.7)	34 (7.0)	14 (1.0)	5 (3.3)
No	791 (26.1)	93 (28.3)	170 (34.8)	521 (35.9)	37 (24.2)
Missing	2189 (72.1)	227 (69.0)	284 (58.2)	916 (63.1)	111 (72.5)
Post-operative stroke (%)					
Yes	10 (0.3)	4 (1.2)	8 (1.6)	8 (0.6)	7 (4.6)
No	2888 (95.2)	307 (93.3)	459 (94.1)	1377 (94.9)	141 (92.2)
Missing	137 (4.5)	18 (5.5)	21 (4.3)	66 (4.5)	5 (3.2)
Pre-operative renal failure (%)					
Yes	27 (0.9)	13 (3.9)	17 (3.5)	25 (1.7)	3 (2.0)
No	2775 (91.4)	297 (90.3)	436 (89.3)	1306 (90.0)	144 (94.1)
Missing	233 (7.7)	19 (5.8)	35 (7.2)	120 (8.3)	6 (3.9)

Table 2 Continued

Characteristics	CABG[a] (*n* = 3035)	Valve and CABG[a] (*n* = 329)	Valve and aorta-surgery (*n* = 488)	Valve-surgery (*n* = 1451)	Ascending aorta (*n* = 153)
NYHA-class[e] (%)					
1	253 (8.4)	18 (5.5)	85 (17.4)	159 (11.0)	54 (35.3)
2	1021 (33.6)	131 (39.8)	221 (45.3)	582 (40.1)	37 (24.2)
3	1269 (41.8)	132 (40.1)	108 (22.1)	482 (33.2)	13 (8.5)
4	215 (7.1)	16 (4.9)	11 (2.3)	43 (3.0)	6 (3.9)
Missing	277 (9.1)	32 (9.7)	63 (12.9)	185 (12.7)	43 (28.1)
Euroscore 1 (mean $\pm$ SD)	1.6 (1.6)	3.1 (1.7)	5.5 (3.0)	2.8 (1.5)	4.7 (3.8)
Ejection fraction (%)					
Normal	666 (21.9)	70 (21.3)	160 (32.8)	446 (30.7)	40 (26.2)
Reduced	179 (5.9)	32 (9.7)	39 (8.0)	88 (6.1)	4 (2.6)
Missing	2190 (72.2)	227 (69.0)	289 (59.2)	917 (63.2)	109 (71.2)

[a]Coronary artery bypass graft surgery.
[b]Sick leave absence.
[c]Standard deviation.
[d]Euro.
[e]New York Heart Association Functional Classification.

Discussion

In this nationwide registry-based cohort study, SL in patients of working age between 18 and 65 years who underwent a first-time open-heart surgery was studied. While previous studies have focused mainly on CABG or valve surgery concerning RTW, this is, to our knowledge, the first study comparing SL in five main cardiac surgery groups. Furthermore, the study identifies both socio-demographic and clinical factors that influence the odds of prolonged SL after treatment. The five surgical procedures investigated in this study reveal a mean SL that is higher than that expected from a clinical point of view after cardiac surgery and our SL data.[18] The mean SL was found to be comparable over all the different interventions, but there was a significant difference between females and males. Furthermore, the clinical and socio-demographic factors before and after surgery seem to impact patients' SL significantly. Previous research has reported that SL varies from 9.3 to 36 weeks after CABG or aortic valve surgery.[19,20] In our study, the mean SL of the whole patient group was found to be 23 weeks. The patients are usually informed about a 6–8-week SL due to the sternotomy after the surgery.[18] The Norwegian social welfare system delivers free and equal access to health care for all inhabitants, regardless of their employment status. The benefits issued by the state are known to be among the most substantial compared with several European countries as they compensate the patients' salary at 100% for 1 year.[21] Studies have demonstrated that when the welfare systems are generous, SL increases in the population,[22] and our study's high SL reflects this observation. If we compare Norway with a country with closely the same benefits, a Swedish study found even higher SL (200 days) after CABG, confirming the fact that generous welfare systems make SL increase.[23] In countries where SL benefits are more restricted, SL duration after cardiac surgery is shorter, as observed in an Australian study where cardiac surgical patients had a mean absence of only 9.3 weeks.[19] The findings of our study are likely to have the greatest relevance for other nations with extensive welfare regulations. This is because the economic and social-security safety nets available to patients, which significantly impact their ability to RTW, are shaped by the unique social characteristics of each country.

Socio-demographic factors related to a prolonged sick leave

Females had significantly higher odds of SL >6 months than men. Our findings are consistent with other studies within the last 20 years, and females are known to have higher odds of delaying RTW compared with males after cardiac surgery.[6,7,24] The trend of females experiencing longer SL than males is observed in Europe; however, conclusive reasons for this difference have not yet been found.[25,26] It is worth noting that females in our study scored significantly higher on the ES1, while male patients scored lower for mortality. Overall, females were classified as medium risk in the ES1. While this might suggest that female patients are sicker when admitted for cardiac surgery, it is important to remember that females automatically get a 1% additive ES1 score compared with men. Hence, these findings align with previous studies indicating that females have a different cardiac health profile than men, which could be a reason for our results concerning SL and female gender.[27] Moreover, the female socio-demographical profile is very different as compared with men. Even though females are more educated now than ever before in history, men still have higher levels of education globally.[28] Furthermore, between the genders, a well-documented pay gap exists, where females have lower pay than men. A similar gap can be observed in most countries in the world.[29] Regardless of their employment status, females are also believed to have greater responsibilities for housework and caring duties at home in comparison to men, which may be a reason for longer SL.[30]

Patients with an educational level of 9 years or secondary school (12–13 years) had significantly higher odds of increased SL >6 months. Patients' educational level seems to impact SL directly. In accordance with other studies, patients with higher education levels resumed work earlier than those with a low academic level.[6,9,31] However, our findings also indicate that patients with secondary education were more prone to an increased SL than those with primary education at the highest level. In addition, there was a clear difference between patients with a university degree and those without a degree. A possible explanation is that higher-educated persons also have a higher degree of health literacy. It is a fact that higher-educated individuals generally have less physically demanding jobs.[32]

Table 3 Odds ratio for the association between cardiac surgical intervention and sick leave at 3–6 and 6–12 months by gender and age categories between the years 2012 and 2021 in five Norwegian cardiac surgical centres

Sex	Surgical intervention	*n* (%)	Mean days (SD[a])	Patients on sick leave ≥3–6 months: *n* (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[b] (95% confidence interval) [*P*-value]	Patients on sick leave >6 months: *n* (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[b] (95% confidence interval) [*P*-value]
Female	Isolated valve	322(41.8)	177.9 (100.1)	244 (75.8)	1.0	1.0	149 (46.3)	1.0	1.0
	Valve and CABG[c]	32 (4.2)	177.7 (124.7)	22 (68.8)	0.7 (0.3, 1.5) [0.382]	0.6 (0.2, 1.5) [0.234]	15 (46.9)	1.1 (0.5, 2.1) [0.948]	0.8 (0.3, 1.9) [0.603]
	Valve and aorta	84 (10.9)	193.8 (95.9)	71 (84.5)	1.7 (0.9, 3.3) [0.090]	1.3 (0.7, 2.7) [0.414]	41 (48.8)	1.1 (0.7, 1.8) [0.678]	1.0 (0.6, 1.8) [0.905]
	CABG[c]	291(37.8)	190.1 (103.4)	227 (78.0)	1.1 (0.8, 1.7) [0.513]	0.9 (0.5, 1.4) [0.584]	146 (50.1)	1.2 (0.9, 1.6) [0.335]	1.0 (0.7, 1.5) [0.965]
	Ascending aorta	41 (5.3)	201.3 (100.7)	36 (87.8)	2.3 (0.9, 6.1) [0.092]	3.0 (0.9, 10.4) [0.084]	25 (69.0)	1.8 (0.9, 3.5) [0.079]	2.5 (1.1, 5.5) [0.022]
Men	Isolated valve	1129 (24.1)	151.5 (93.6)	752 (66.6)	1.0	1.0	370 (32.8)	1.0	1.0
	Valve and CABG[c]	297 (6.3)	164.3 (96.6)	216 (72.7)	1.3 (1.0, 1.8) [0.045]	1.5 (1.1, 2.2) [0.019]	114 (38.4)	1.3 (1.0, 1.7) [0.070]	1.3 (0.9, 1.7) [0.152]
	Valve and aorta	404 (8.6)	148.6 (95.0)	267 (66.1)	1.0 (0.8, 1.2) [0.850]	0.9 (0.7, 1.1) [0.329]	120 (29.7)	0.9 (0.7, 1.1) [0.256]	0.8 (0.6, 1.1) [0.076]
	CABG[c]	2744 (58.6)	160.5 (99.5)	1897 (69.1)	1.1 (1.0, 1.3) [0.125]	1.1 (0.9, 1.3) [0.517]	980 (35.7)	1.1 (1.0, 1.3) [0.081]	1.1 (0.9, 1.3) [0.460]
	Ascending aorta	112 (2.4)	163.7 (101.0)	81 (72.3)	1.3 (0.9, 2.0) [0.221]	1.4 (0.9, 2.4) [0.519]	39 (34.8)	1.1 (0.7, 1.6) [0.660]	1.3 (0.8. 2.1) [0.251]
Age ≤55 years	Isolated valve	694 (31.3)	158.0 (92.9)	485 (69.9)	1.0	1.0	249 (35.9)	1.0	1.0
	Valve and CABG[c]	92 (4.1)	166.2 (98.0)	67 (72.9)	1.1 (0.7, 1.9) [0.562]	1.2 (0.7, 2.2) [0.526]	36 (39.1)	1.1 (0.7, 1.8) [0.542]	1.0 (0.6, 1.7) [0.907]
	Valve and aorta	276 (12.4)	155.9 (97.4)	186 (67.4)	0.9 (0.7, 1.2) [0.448]	0.8 (0.6, 1.1) [0.182]	92 (33.3)	0.9 (0.7, 1.2) [0.454]	0.9 (0.6, 1.2) [0.424]
	CABG[c]	1076 (48.5)	167.9 (100.3)	772 (71.8)	1.1 (0.9, 1.3) [0.399]	1.0 (0.8, 1.4) [0.536]	432 (40.1)	1.2 (1.0, 1.5) [0.072]	1.2 (0.9, 1.5) [0.152]
	Ascending aorta	82 (3.7)	161.7 (101.0)	59 (72.0)	1.1 (0.7, 1.8) [0.699]	1.1 (0.6, 2.1) [0.676]	31(37.8)	1.1 (0.7, 1.7) [0.731]	1.3 (0.8, 2.3) [0.303]
Age >55 years	Isolated valve	757 (23.4)	156.8 (98.3)	511 (68.0)	1.0	1.0	270 (35.7)	1.0	1.0
	Valve and CABG[c]	237(7.3)	165.3 (100.3)	171 (72.2)	1.2 (0.9, 1.7) [0.179]	1.5 (1.0, 2.3) [0.039]	93 (39.2)	1.2 (0.9, 1.6) [0.319]	1.3 (0.9, 1.9) [0.161]
	Valve and aorta	212 (6.6)	157.2 (95.8)	152 (71.7)	1.2 (0.9, 1.7) [0.246]	1.2 (0.6, 1.1) [0.464]	69 (32.6)	0.9 (0.6, 1.2) [0.400]	0.8 (0.5, 1.1) [0.156]
	CABG[c]	1959 (60.5)	160.8 (100.2)	1352 (69.0)	1.1 (0.9, 1.3) [0.447]	1.1 (0.9, 1.3) [0.578]	694 (35.5)	1.0 (0.8, 1.2) [0.906]	1.0 (0.8, 1.3) [0.834]
	Ascending aorta	71 (2.2)	187.6 (101.9)	58 (81.7)	2.1 (1.2, 4.0) [0.016]	3.3 (1.4, 7.5) [0.005]	33 (46.5)	1.6 (1.0, 2.6) [0.072]	2.0 (1.1, 3.6) [0.017]

[a]Standard deviation.
[b]Adjusted model for age, comorbidities, education, and region.
[c]Coronary artery bypass graft surgery.

Table 4 Odds ratio for the association between sick leave at ≥3–6 and >6–12 months with patient demographic, region, comorbidity, and post-operative complications between the years 2012 and 2021 in five Norwegian cardiac surgical centres

	Patients on sick leave ≥3–6 months			Patients on sick leave >6 months		
	n (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[a] (95% confidence interval) [*P*-value]	*n* (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[a] (95% confidence interval) [*P*-value]
All patients	3813 (69.9)			1999 (36.6)		
Sex						
Male	3213 (68.6)	1.0	1.0	1623 (34.6)	1.0	
Female	600 (77.9)	1.6 (1.4, 1.9) [0.001]	1.7 (1.4, 2.1) [0.001]	376 (48.8)	1.8 (1.5, 2.1) [0.001]	1.8 (1.5, 2.2) [0.001]
Age						
>55 years	2244 (58.8)	1.0	1.0	1159 (58.0)	1.0	
≤55 years	1569 (41.2)	0.9 (0.8, 1,1) [0.293]	1.3 (1.0, 1.7) [0.048]	840 (42.0)	0.9 (1.1, 1.8) [0.128]	0.9 (0.7, 1.2) [0.611]
Geographical region						
West	1169 (68.5)	1.0	1.0	552 (32.3)	1.0	1.0
North	392 (70.2)	1.1 (0.9, 1.3) [0.423]	1.1 (0.9, 1.4) [0.442]	211 (37.8)	1.3 (1.0, 1.6) [0.017]	1.3 (1.0, 1.6) [0.031]
East	1432 (71.6)	1.2 (1.0, 1.3) [0.034]	1.2 (1.1, 1.4) [0.007]	780 (39.0)	1.3 (1.2, 1.5) [0.001]	1.4 (1.2, 1.6) [0.001]
South	135 (68.9)	1.0 (0.7, 1.4) [0.901]	1.1 (0.8, 1.5) [0.738]	73 (37.2)	1.2 (0.9, 1.7) [0.165]	1.2 (0.9, 1.7) [0.214]
Mid	199 (72.1)	1.2 (0.9, 1.6) [0.223]	1.2 (0.9, 1.7) [0.186]	110 (39.9)	1.4 (1.1, 1.8) [0.014]	1.3 (1.0, 1.8) [0.064]
Education						
University >3 years	960 (61.9)	1.0	1.0	458 (29.5)	1.0	1.0
University 1–3 years	677 (65.8)	1.2 (1.0, 1.4) [0.042]	1.2 (1.0, 1.4) [0.159]	345 (33.5)	1.2 (1.1, 1.4) [0.031]	1.1 (0.9, 1.4) [0.238]
Secondary education 1–3 years	1825 (76.1)	2.0 (1.7, 2.3) [0.001]	2.0 (1.7, 2.4) [0.001]	1019 (42.5)	1.8 (1.5, 2.0) [0.001]	1.8 (1.6, 2.1) [0.001]
Primary education	167 (79.2)	1.8 (1.7, 3.3) [0.001]	1.8 (1.3, 2.7) [0.001]	93 (44.1)	1.9 (1.4, 2.5) [0.001]	1.5 (1.1, 2.1) [0.013]
Income EUR[b]						
<33 000	463 (66.7)	1.0	1.0	260 (37.5)	1.0	1.0
62 000–33 000	2105 (76.3)	1.6 (1.3, 1.9) [0.001]	1.8 (1.4, 2.2) [0.001]	1155 (41.9)	1.2 (1.0, 1.4) [0.036]	1.3 (1.1, 1.7) [0.005]
95 000–62 000	714 (65.0)	0.9 (0.8, 1.1) [0.464]	1.2 (1.0, 1.6) [0.106]	321 (29.2)	0.7 (0.6, 0.8) [0.001]	0.9 (0.7, 1.1) [0.360]
≥95 000	531 (58.7)	0.7 (0.6, 0.9) [0.001]	0.9 (0.7, 1.1) [0.226]	263 (29.1)	0.7 (0.6, 0.8) [0.001]	0.9 (0.7, 1.1) [0.291]
BMI[c]						
Underweight	15 (75.0)	1.0	1.0	8 (40.0)	1.0	1.0
Normal weight	735 (65.9)	0.6 (0.2, 1.8) [0.399]	0.7 (0.2, 2.4) [0.535]	401 (36.0)	0.8 (0.3, 2.1) [0.710]	1.2 (0.4, 3.7) [0.756]
Overweight	1408 (69.0)	0.7 (0.3, 2.0) [0.564]	0.8 (0.2, 2.8) [0.664]	721 (35.3)	0.8 (0.3, 2.0) [0.644]	1.2 (0.4, 3.6) [0.798]
Obese	894 (76.2)	1.1 (0.4, 3.0) [0.899]	1.1 (0.3, 4.4) [0.936]	484 (41.3)	1.1 (0.4, 2.6) [0.910]	1.4 (0.5, 4.3) [0.583]
Diabetes	521 (74.3)	1.3 (1.1, 1.6) [0.005]	1.2 (1.0, 1.5) [0.050]	300 (42.8)	1.3 (1.1, 1.6) [0.001]	1.3 (1.1, 1.6) [0.002]
Hypertension	1487 (71.1)	1.1 (1.0, 1.3) [0.077]	1.1 (0.9, 1.3) [0.267]	794 (38.0)	1.1 (1.0, 1.2) [0.146]	1.0 (0.9, 1.1) [0.917]
Lung disease	95 (76.6)	1.5 (1.0, 2.4) [0.046]	1.3 (0.8, 2.2) [0.274]	60 (48.4)	1.7 (1.2, 2.5) [0.004]	1.3 (0.8, 2.0) [0.276]
Arterial disease	78 (6.6)	0.9 (0.6, 1.4) [0.642]	0.8 (0.5, 1.3) [0.384]	49 (7.8)	0.8 (0.9, 1.9) [0.211]	1.0 (0.6, 1.5) [0.898]
Previous myocardial infarction[d]	241 (73.9)	1.4 (1.0, 1.8) [0.024]	1.3 (0.9, 1.7) [0.148]	156 (47.9)	1.8 (1.4, 2.3) [0.001]	1.6 (1.2, 2.1) [0.002]
Post-operative stroke	28 (75.7)	1.3 (0.6, 2.9) [0.435]	1.4 (0.5, 3.5) [0.520]	23 (62.2)	2.9 (1.5, 5.6) [0.002]	3.2 (1.3, 7.5) [0.008]
Post-operative renal failure	66 (77.7)	1.5 (0.9, 2.5) [0.110]	1.8 (0.9, 3.4) [0.104]	44 (51.8)	1.9 (1.2, 2.9) [0.003]	1.9 (1.1, 3.3) [0.015]

[a] Adjusted model for age, sex comorbidities, region, and education.
[b] Euro.
[c] Body mass index.
[d] Three months prior surgery.

Table 5 Odds ratio for the association between cardiac surgical intervention and sick leave at 3–6 and 6–12 months with the patients' work category

	Patients on sick leave ≥3–6 months			Patients on sick leave >6 months		
	n (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[a] (95% confidence interval) [*P*-value]	*n* (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[a] (95% confidence interval) [*P*-value]
All	3768 (69.8)			1974 (36.6)		
Missing	45 (1.2)			25 (1.3)		
Professional categories						
Military	139 (66.2)	1	1	59 (28.1)	1.0	1.0
Academics	1842 (64.1)	0.9 (0.7, 1.2) [0.532]	0.9 (0.7, 1.3) [0.645]	906 (31.5)	1.2 (0.9, 1.6) [0.304]	1.3 (0.9, 1.8) [0.206]
Sales and services	588 (75.8)	1.6 (1.1, 2.2) [0.005]	1.5 (1.0, 2.1) [0.052]	343 (44.2)	2.1 (1.4, 2.8) [0.001]	1.9 (1.3, 2.9) [0.001]
Primary industries	26 (63.4)	0.9 (0.4, 1.8) [0.732]	0.9 (0.4, 1.9) [0.691]	14 (34.2)	1.3 (0.7, 2.7) [0.436]	1.3 (0.5, 3.0) [0.589]
Craftmanship	520 (78.8)	1.9 (1.3, 2.7) [0.001]	2.1 (1.4, 3.1) [0.001]	285 (43.2)	1.9 (1.4, 2.7) [0.001]	2.5 (1.7, 3.8) [0.001]
Machine and transport workers	486 (77.6)	1.8 (1.3, 2.5) [0.001]	2.0 (1.4, 3.0) [0.001]	274 (43.8)	2.0 (1.4, 2.8) [0.001]	2.4 (1.7, 3.6) [0.001]
Occupations without any requirements	167 (79.2)	1.9 (1.3, 3.0) [0.003]	1.5 (1.0, 2.5) [0.083]	93 (44.1)	2.0 (1.3, 3.0) [0.001]	1.7 (1.1, 2.8) [0.018]

[a]Adjusted model for age, sex, region, and comorbidities.

Our study found significant differences in the odds of SL >6 months regarding patients' type of work. The typical 'blue collar' work, where patients face manual tasks, had a two-fold chance for a high SL compared with 'white collar' professions that are less physically demanding. To prevent sternal complications, patients are advised to restrict lifting up to 8–12 weeks following surgery.[33] Even if the post-operative period restricts heavy weightlifting or using the arms due to the sternotomy, the SL duration in our study was longer than expected from a clinical perspective for all the surgical interventions. Patients working in sales, service, and care professions had double odds of a prolonged SL >6 months. According to the latest International Labour Organization database figures, medical caring personnel are 88% female and 12% male.[34] Physically demanding tasks typically performed in medical care professions may partly explain the increased SL in women. These findings confirm earlier studies on the difference between professionals and their work types.[8,12,24,35,36] Previous research has addressed the need for a more tailored evaluation of sternal precautions adjusted to the type of work the patients perform.[37]

Previous studies have consistently pointed out that a patient's economic situation can serve as a significant indicator for predicting the duration of SL.[6,9] In alignment with these earlier findings, this study sought to explore the relationship between patients' income levels and their SL outcomes. Surprisingly, the results of this study revealed a deviation from the previously reported trends. It was observed that patients with an annual income below the average wages in Norway had higher odds of experiencing a shorter SL when compared with patients earning average salaries. This unexpected finding challenges the conventional belief that individuals with lower incomes are more prone to an extended period of absence from work.[6,9,31,38] These findings highlight the complexity of the relationship between socioeconomic factors and SL outcomes. This call for further investigation to understand the underlying mechanisms and potential confounding variables that contribute to these contrasting results.

The study findings revealed intriguing regional variations in the duration of SL. Specifically, the eastern region displayed higher odds of SL lasting more than 6 months, whereas the western region exhibited a tendency towards shorter SL durations. This regional disparity in SL duration raises questions about the underlying factors contributing to these differences. Previous studies have reported that patients residing in rural areas tend to have faster RTW compared with those in urban areas.[11,31,35] However, this study discovered that regional differences in SL duration were not influenced by an overrepresentation of specific manual professions or educational levels. Furthermore, clinical data regarding ES1, NYHA class, and comorbidities were evenly distributed across the regions, ruling out these factors as potential explanations for the observed regional variations. In light of these intriguing findings, a hypothesis emerges that other underlying mechanisms may be at play, specific to each region, which influence the duration of SL. Possible factors warranting exploration could include differences in healthcare access, availability of rehabilitation services, socioeconomic conditions, cultural attitudes towards work and illness, or variations in work-related characteristics.

Clinical factors related to prolonged sick leave

This study found that comorbidities and previous diseases play an essential role in SL after cardiac surgery. Patients receiving diabetic treatment had increased odds of a significantly longer SL than other patients. From earlier research, it is observed that the management of diabetic patients is essential during all phases of the hospital stay and diabetes is an independent risk factor for mortality in cardiac surgery patients.[39] Compared with patients with normalized blood levels, hyperglycaemia increases the likelihood of wound infections,

Table 6 **Odds ratio for the association between sick leave absence at ≥3 and >6 months with the New York Heart Association Functional Classification, ejection fraction, and Euroscore 1**

		Patients with sick leave ≥3–6 months			Patients with sick leave >6 months	
	n (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[a] (95% confidence interval) [*P*-value]	*n* (%)	Crude odds ratio (95% confidence interval) [*P*-value]	Adjusted odds ratio[a] (95% confidence interval) [*P*-value]
	3813 (69.9)			1999 (36.6)		
NYHA-class [b]						
1	376 (9.9)	1.0	1.0	184 (32.3)	1.0	1.0
2	1364 (35.7)	1.1 (0.9, 1.4) [0.281]	1.2 (0.9, 1.5) [0.163]	668 (33.5)	1.1 (0.9, 1.3) [0.593]	1.0 (0.8, 1.3) [0.796]
3	1441(37.8)	1.3 (1.1, 1.6) [0.007]	1.3 (1.1, 1.6) [0.037]	807 (40.3)	1.4 (1.2, 1.7) [0.001]	1.3 (1.1, 1.7) [0.028]
4	224 (5,9)	1.7 (1.2, 2.4) [0.001]	1.6 (1.1, 2.3) [0.014]	137 (47.1)	1.9 (1.4, 2.5) [0.001]	1.8 (1.3, 2.5) [0.001]
Missing	600 (10.7)					
Ejection fraction						
Normal	934 (24.5)	1.0	1.0	490 (35.5)	1.0	1.0
Reduced	249 (6.5)	1.3 (1.0, 1.7) [0.063]	1.3 (0.9, 1.7) [0.144]	141 (41.2)	1.3 (1.0, 1.6) [0.048]	1.2 (0.9, 1.6) [0.177]
Missing	3732 (69.0)					
Euroscore 1						
Low risk (0–2)	1383 (36.3)	1.0	1.0	668 (33.1)	1.0	1.0
Medium risk (3–5)	743 (19.5)	1.2 (1.0, 1.4) [0.029]	1.2 (1.0, 1.5) [0.056]	400 (38.9)	1.3 (1.1, 1.5) [0.001]	1.3 (1.1, 1.6) [0.006]
High risk (≥6)	90 (2.4)	1.1 (0.7, 1,6) [0.751]	1.0 (0.6, 1.5) [0.900]	52 (40.3)	1.4 (1.0, 2.0) [0.092]	1.3 (0.8, 2.0) [0.327]
Missing	2278(41.8)					

[a]Adjusted model for age, sex comorbidities, region, and education.
[b]New York Heart Association Functional Classification.

pre-operative renal failure, and a more extended hospital stay in cardiac surgery patients.[39]

Another decisive clinical factor for an increased SL was found in patients with a previous MI <3 months prior to cardiac surgery. Available literature mentions pre- and post-operative MIs, while the impact of recent pre-surgery MIs is rarely mentioned.[40] More research on pre-MIs and SL is therefore warranted. Patients with a recent MI are known to be at risk of depression after the incident, as are patients after cardiac surgery.[41,42] Recognizing this, it could be interpreted that patients with a recent MI who were operated on shortly afterwards have an increased risk of more complicated issues with regard to depression. A planned treatment that improves a condition that has worsened over time is a different starting point than having a life-threatening condition followed by heart surgery. If hospitalization due to an MI occurred shortly before the cardiac surgical intervention, it is reasonable to assume that the hospitalization contributed to a post-hospital syndromed and consequently resulted in an extended period of medical leave.[43]

Stroke after cardiac surgery is a severe complication and has been reported with an incidence of up to 4.6%.[44] In our study, the incidence of perioperative stroke in the national registry was significantly lower at 0.7%. Patients suffering a post-operative stroke were identified in the study as those with the absolute highest odds of prolonged SL. In general, stroke patients require around 90 days to RTW, and many do not return directly to full-time work during the first year. Moreover, about 50% of stroke patients have some degree of post-stroke cognitive impairment during the first year.[45,46] Understandably, the patients who suffer from the effects of stroke will have a prolonged period of SL, as they have to cope with both post-stroke issues and the impact of their cardiac surgeries.

Patients who develop renal failure were found to have double OR of SL >6 months in this study. Acute renal failure is a significant post-operative complication, and the incidence has been reported in the literature to vary between 5 and 19% after cardiac surgery. Renal failure is a severe condition that is associated with reduced long-term survival.[47,48] Previous studies have focused on CABG surgery, while this study, together with four other types of open-heart surgery, describes a lower incidence than demonstrated in previous reports.[47] The consequences of renal failure on patients are apparent, as they experience a prolonged hospital stay whether this was due to dialysis or not. This extended hospitalization may be one of the contributing factors to the increased odds of SL. Individuals who become dependent of dialysis after hospital discharge are more likely to have low employment rates, based on earlier research involving dialysis patients.[49]

Surgery involving the ascending aorta is widely recognized as carrying a higher risk of perioperative complications, including bleeding and stroke, in comparison to aortic valve surgery. Previous studies have consistently highlighted these increased risks associated with AAS.[50] In our study, we sought to explore the impact of different cardiac surgical interventions on SL duration. Interestingly, we found that AAS was significantly associated with longer SL durations, particularly among women. Notably, women undergoing AAS had more than a two-fold increased odds of experiencing prolonged SL lasting over 6 months compared with those undergoing AVR. Our study also identified that patients >55 years undergoing AAS also have a two-fold increased odds of SL >6 months. These findings highlight the considerable impact of AAS on patients' ability to RTW, particularly for women. The higher odds of prolonged SL after AAS suggest that the recovery process for this procedure may be more complex and demanding, requiring extended rehabilitation and convalescence periods.

Our study also corroborated existing literature by demonstrating that aortic surgery, including surgery on the ascending aorta, was associated with the highest frequency of bleeding and stroke compared with other cardiac interventions.[51] These findings reinforce the known risk profile associated with aortic surgeries and underline the importance of closely monitoring and managing these potential complications. Taken together, our study provides valuable insights into the relationship between different cardiac surgical interventions, SL, and perioperative complications. Understanding the specific challenges and risks associated with AAS, particularly in relation to prolonged SL and perioperative complications, can aid healthcare professionals in optimizing patient care and facilitating timely RTW.

This study found the NYHA score to be predictive of high odds of SL after cardiac surgery, assumed to be mainly related to cardiac failure. Patients with NYHA score of III or IV were found to have increased SL. NYHA score related to patients' RTW has been demonstrated in previous studies, although this has only been evaluated for CABG or valve surgery.[6,12,52] Our study shows a strong relationship between the NYHA score and SL duration over all types of open-heart surgery. This confirms previous results and identifies the increase of SL in patients undergoing combined AVR/CABG surgery, isolated AAS, and combined AVR and aortic surgery. As no patients in the surgical groups had undergone less invasive surgery, including off-pump CABG, application of rapid deployment aortic valve prosthesis, or mini-thoracotomy, the impact of minimal invasive methods has not been evaluated in this study. Whether minimally invasive surgical techniques can reduce SL following cardiac surgery may be an appropriate research question for future studies.

According to the ES1 in our study, female patients have a higher risk of post-operative mortality. However, in this study, lung disease was the only pre-operative disease that was more frequent in females compared with males. Female patients' odds of longer SL seem unrelated to their degree of illness on admission to the hospital. From the literature, it can be observed that in the first 5 years after cardiac surgery, females have inferior cardiac and cerebrovascular outcomes than men and also a tendency to a higher risk of perioperative MI.[53] Unfortunately, female patients with cardiovascular diseases have been underdiagnosed and understudied. Recent publications have specified several strategies for preventing and treating cardiovascular disease in women.[27,54] Further studies on SL in direct relation to females are warranted in the future.

Strengths and limitations of the study

The Norwegian government funds the NRCS, and the register offers a unique setting for performing epidemiological studies. Combining this resource with the NWLA provides a large sample based on clinical and work-related data, using an entire cardiac surgical population from five cardiac surgical centres. The major strength of our study is the large sample size, and the comparison of five distinct surgical procedures based on clinical and socio-demographic factors. Working cardiac surgical patients in Norway were included in this study, except for those who were self-employed. The number of participants offered satisfactory statistical power for the analyses. This study provides us with the prevalence of SL in relation to working cardiac surgical patients in Norway and may be generalizable to other Western high-income countries.

While we have used data on SL that is considered reliable, the NWLA lacks information on patients' employment status after the SL period, making it challenging to identify the actual number of patients returning to work after cardiac surgery. Furthermore, the group studied is a sub-group consisting of actively working patients. Self-employed or unemployed patients are not included in this study, and details of SL for these groups therefore cannot be provided. Each cardiac surgical centre plots information on patients in the NRCS, and plotted clinical information can differ between the centres. We acknowledge that there are missing values in the NRCS register, and some variables may be underreported.

Conclusion

This nationwide registry-based cohort study indicates that the patient's socio-demographic and clinical background is associated with increased SL. This study has revealed important and new socio-demographic and clinical knowledge on five different types of conventional open-heart surgery, valid for all healthcare personnel working with cardiac surgical patients. Further studies are required to investigate the mechanisms underlying the patients at risk, and focus on surgical techniques and post-operative medical care targeted at decreasing the odds of a prolonged SL in these groups should be highlighted.

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Author contribution

The study was initiated and designed by Michael Mortensen and Asgjerd L. Moi. Mortensen participated in all parts of the study, performed the data analyses with the statistical support of Roy Miodini Nilsen, and prepared the first and final drafts of the manuscript. All authors contributed to the interpretation of data, as well as revisions and completion of the final manuscript.

Data availability

Data from the NRCS and the NWLA have been used in this article. The interpretation and reporting of these data are the sole responsibility of the authors, and no endorsement by the NRCS or NWLA is intended or should be inferred. The data underlying this article cannot be shared publicly due to the privacy of individuals in the study.

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