



UK Health
Security
Agency

Surveillance of surgical site infections in NHS hospitals in England

April 2022 to March 2023

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Main points

In the financial year 2022 to 2023, 183 NHS hospitals representing 124 NHS trusts and 8 Independent Sector (IS) NHS treatment centres submitted surveillance data for 125,095 surgical procedures to the UK Health Security Agency (UKHSA, previously Public Health England) Surgical Site Infection (SSI) Surveillance Service. The number of hospitals contributing data remained the same as in the previous year, while the number of trusts decreased from 125 due to trust mergers. Across 17 surgical categories, 1,122 SSIs were detected during the inpatient stay or on readmission.

A total of 102,025 procedures were submitted as part of mandatory surveillance of orthopaedic surgery, an increase of 10.2% from 92,608 procedures in the previous financial year. Two trusts did not meet the mandatory surveillance participation requirements. A total of 23,070 procedures were submitted as part of voluntary surveillance spanning 13 other surgical categories, a 1.2% increase from 22,804 procedures in the previous financial year (2021 to 2022). However, the number of submitted procedures was still lower than pre-pandemic (financial year 2019 to 2020) for both mandatory categories (4.3% lower than 106,630 procedures in financial year (FY) 2019 to 2020) and voluntary categories (17.2% lower than 27,873 procedures in FY 2019 to 2020).

Cardiac surveillance (coronary artery bypass graft (CABG) and non-CABG) continued to have the highest degree of continuous surveillance among participating hospitals (CABG: 85% and non-CABG: 100%).

Nine trusts were identified as high outliers for the mandatory orthopaedic surveillance categories (3 in hip replacement, 2 in knee replacement, one in reduction of long bone fracture and 3 in repair of neck of femur).

Ten-year trends in inpatient and readmission SSI risk showed a decrease for 9 of 10 categories assessed, the exception being small bowel surgery.

The SSI risk increased marginally for 8 out of 10 categories (with at least 5 participating hospitals) including hip replacement, reduction of long bone fracture and repair of neck of femur between 2021 to 2022 and 2022 to 2023.

Among SSIs with accompanying microbiological confirmation, Enterobacterales continued to make up the highest proportion of causative organisms across all surgical categories in financial year 2022 to 2023 for both superficial (32.6%) and deep or organ and space (26.8%) SSIs. The proportion of SSIs caused by meticillin-resistant *Staphylococcus aureus* (MRSA) decreased (superficial 3.1% and 2.1%, deep 2.7% and 2.5%), while the proportion caused by meticillin-sensitive *Staphylococcus aureus* (MSSA) increased (superficial 15.3% and 17.2%, deep 17.4% and 18%) compared to the previous year.

Surgical Site Infection (SSI) Surveillance Service

Introduction

This report summarises data submitted by NHS hospitals and independent sector (IS) NHS treatment centres in England to the national SSI Surveillance Service (SSISS), UK Health Security Agency (UKHSA, previously Public Health England (PHE)). The aim of the national surveillance program is to enhance the quality of patient care by encouraging hospitals to use data obtained from the surveillance to compare their rates of SSI over time and against a national benchmark and to use this information to review and guide clinical practice.

The SSISS provides an infrastructure for hospitals to collect data on 17 surgical categories spanning general surgery, cardiothoracic, neurosurgery, gynaecology, vascular, gastroenterology and orthopaedics. Surveillance is targeted at open surgical procedures, which carry a higher risk of infection than minimally invasive ('keyhole') procedures (1, 2), however laparoscopic-assisted procedures are included for some categories.

The SSISS was established by the Public Health Laboratory Service (PHLS, a predecessor of UKHSA) in 1997. From April 2004, NHS trusts performing orthopaedic surgery have been mandated by the Department of Health and Social Care (DHSC) to carry out surveillance for a minimum of 3 consecutive months per financial year in at least one of 4 orthopaedic categories: hip replacement, knee replacement, repair of neck of femur or reduction of long bone fracture (3). NHS trusts that do not carry out orthopaedic surgery are exempt from mandatory participation and can report on other types of surgery if they choose to do so. NHS hospital participation in other categories remains voluntary.

This report includes surveillance data submitted to the SSISS based on surgery which took place from 1 April 2013 to 31 March 2023, with a focus on the latest financial year (2022 to 2023), and a comparison to the previous financial year (2021 to 2022).

For the first time, we also present data on ethnicity and Index of Multiple Deprivation (IMD) obtained from NHS England Hospital Episode Statistics (HES) to investigate association between social determinants of health and the risk of SSI.

Methods

SSISS data collection

The UKHSA SSISS protocol outlines a standard methodology, including case definitions and case finding methods, which all participating hospitals must adhere to (4). Hospitals participating in UKHSA's national SSI surveillance programme are strongly encouraged to have staff attend the UKHSA SSISS quarterly training before starting surveillance in order to maintain the quality of surveillance data.

Surveillance data is collected prospectively on a quarterly basis and includes all eligible patients undergoing surgery in pre-selected surgical categories during each 3-month period (quarter). Patients are followed-up to identify SSIs for 30 days after surgery for non-implant procedures and for one year for procedures involving a prosthetic implant. A set of demographic and surgery-related data is collected for each eligible procedure and submitted to the UKHSA SSISS via a secure web-based application.

After each completed quarter, data is subject to quality assurance processes by UKHSA SSISS to identify anomalies or missing data. Participating hospitals can download automated confidential reports securely from the web application for dissemination within their trust. These reports provide hospitals' crude and risk-stratified SSI risk and the corresponding national benchmark by surgical category.

As part of ongoing support to help hospitals monitor their SSI risk, the UKHSA SSISS team analyse submitted data at quarterly intervals to identify 'outliers', defined as hospitals whose SSI risk is above the national 90th percentile ('high outliers') or below the 10th percentile ('low outliers') for each surgical category. UKHSA alerts these hospitals of their outlier status and encourages them to investigate possible reasons. Hospitals identified as 'low outliers' are asked to investigate their case ascertainment methods to ensure cases are not being missed, while hospitals identified as 'high outliers' are asked to examine their clinical practices and discuss their results at multidisciplinary team meetings to explore possible reasons and potential problems at the earliest opportunity. UKHSA offers support to outlier hospitals to assist them with further investigations, including in-depth bespoke analyses and on-site visits to provide further analytical and clinical advice.

Case finding

Active surveillance is undertaken by hospital surveillance staff to identify patients with SSIs during their initial inpatient stay. Hospitals are also required to have systems in place to identify patients post discharge, subsequently readmitted to hospital with an SSI. SSIs identified on readmission are assigned to the hospital where the original operation took place. Other post-discharge surveillance (PDS) methods are recommended and strongly encouraged for short-stay procedures such as breast surgery where the majority of patients are discharged on the day of surgery. They comprise: a) systematic review and documentation of patients attending

outpatient clinics or seen at home by hospital clinical staff trained to apply the case definitions and b) wound healing post-discharge questionnaires (PDQs) completed by the patient or their carer at 30 days after their operation (4). SSIs detected through PDQs are recorded as 'patient reported only' if they have not been identified by one of the other detection methods involving a hospital clinician.

As other forms of PDS are optional, data derived from these methods is not currently included in the national benchmarks, or used for outlier assessment, to ensure comparability of data. The results in this national report do not feature optional PDS data, but its use remains important at the local level to provide a more complete measure of an individual hospital's infection risk, especially for categories with short post-operative length of stay, such as breast surgery.

Case definitions

The UKHSA SSISS protocol defines SSIs according to standard clinical criteria for infections that affect the superficial tissues (skin and subcutaneous layer) of the incision and those that affect the deeper tissues (deep incisional or organ/space). These are based on the definitions established by the US Centers for Disease Control and Prevention (CDC) (5) with minor modifications to 2 of the criteria, namely: i) presence of pus cells for infections determined by positive microbiology without obvious clinical signs and symptoms and ii) at least 2 clinical signs and symptoms of infection to accompany a clinician's diagnosis for superficial incisional infections.

Data enrichment

The Hospital Episode Statistics (HES) Admitted Patient Care (APC) dataset was used to obtain data on patients' ethnicity and relative deprivation as measured by the small-area index of multiple deprivation (IMD) score based on the patient's area of residence at the time of surgery (6). The HES dataset contains comprehensive information about individual patients admitted to NHS hospitals including clinical (diagnoses and operations), patient (age group, gender and ethnicity), administrative (dates and methods of admission and discharge) and geographical (place of treatment and residence) information.

Ethnic group classifications (as defined in the 2001 census) were regrouped due to small numbers of inpatient and readmission SSIs for ethnic groups into:

- white
- Asian
- black
- mixed
- other
- unknown (7)

The IMD is an overall relative measure of deprivation formed by combining 7 domains of deprivation which are:

- income deprivation (22.5%)
- employment deprivation (22.5%)
- education, skills and training deprivation (13.5%)
- health deprivation and disability (13.5%)
- crime (9.3%)
- barriers to housing and services (9.3%)
- living environment deprivation (9.3%)

These are counted according to their respective weights for lower-super output areas (LSOA, small areas of a similar population size of about 1,500 residents or 650 households; the number of LSOAs for 2019 indices was 32,844 (based on revision following 2011 census)). The LSOA with a rank of 1 is the most deprived and the LSOA with a rank of 32,844 is least deprived. The report presents SSIS data by IMD deciles (the number of LSOAs divided into 10 equal groups according to their deprivation rank) rather than individual ranks with decile 1 representing the most deprived LSOAs and decile 10 the least deprived LSOAs (8).

Data governance

The linkage of HES data was justified based on Regulation 3: Communicable disease and other risks to health of The Health Service (Control of Patient Information) Regulation 2002.

Analyses presented in this report

Surveillance data for surgical procedures for a 10-year period, 1 April 2013 to 31 March 2023, was extracted on 28 September 2023 for this report. For procedures performed in the last few months of the 2022 to 2023 financial year and subject to a one-year follow-up (surgery involving the insertion of prosthetic implant), late onset infections reported after the data was extracted will not be captured, although these constitute very small numbers (9). Trust-level results provided in the next annual report will include updates reflecting any late onset infections reported since publication of this annual report. Data for financial year 2021 to 2022 was refreshed and are presented in the accompanying [Trust tables](#).

The SSI risk described in this report is the number of SSI occurring following surgery, expressed as a percentage and represents cumulative incidence. Incidence density was calculated to account for differences in the length of follow-up in hospital and was calculated as number of inpatient SSIs per 1,000 patient days of follow-up. Where applicable, exact 95% confidence intervals have been provided for results. A binomial distribution was assumed for SSI risk, with the exception of incidence density which was assumed to follow a Poisson distribution.

This year's report has new analyses which describe the distribution of SSI risk by social determinants of health. These analyses are descriptive, and do not adjust for other factors such as patient age or sex. Where meaningful, we have calculated risk ratios which compare the risk in one group to the risk in another group. The formula for these calculations can be found in the [Glossary](#).

When calculating risks, a minimum surgical volume threshold is applied at a hospital level as follows: for hip or knee replacement and abdominal hysterectomy, any hospitals with less than 95 operations submitted over 5 years are excluded. For all other surgical categories, a threshold of 45 or more operations was used. At the national level, SSI risk results were restricted to those surgical categories that meet a minimum threshold for hospital participation. For benchmarking purposes, the last 5 years of data including the current financial year is used (1 April 2018 to 31 March 2023).

Funnel plots were produced to compare SSI risk across NHS trusts and treatment centres for the most recent financial year for the mandatory orthopaedic categories (10). The plots account for differences in surgical volume and identify trusts that fall within the expected variation and those that are outliers (SSI incidence falling above or below the 95% confidence limits).

A [supplement to this report](#) contains SSI risk results from the financial years 2021 to 2022 and 2022 to 2023 by NHS trust or treatment centre.

SSISS operational overview

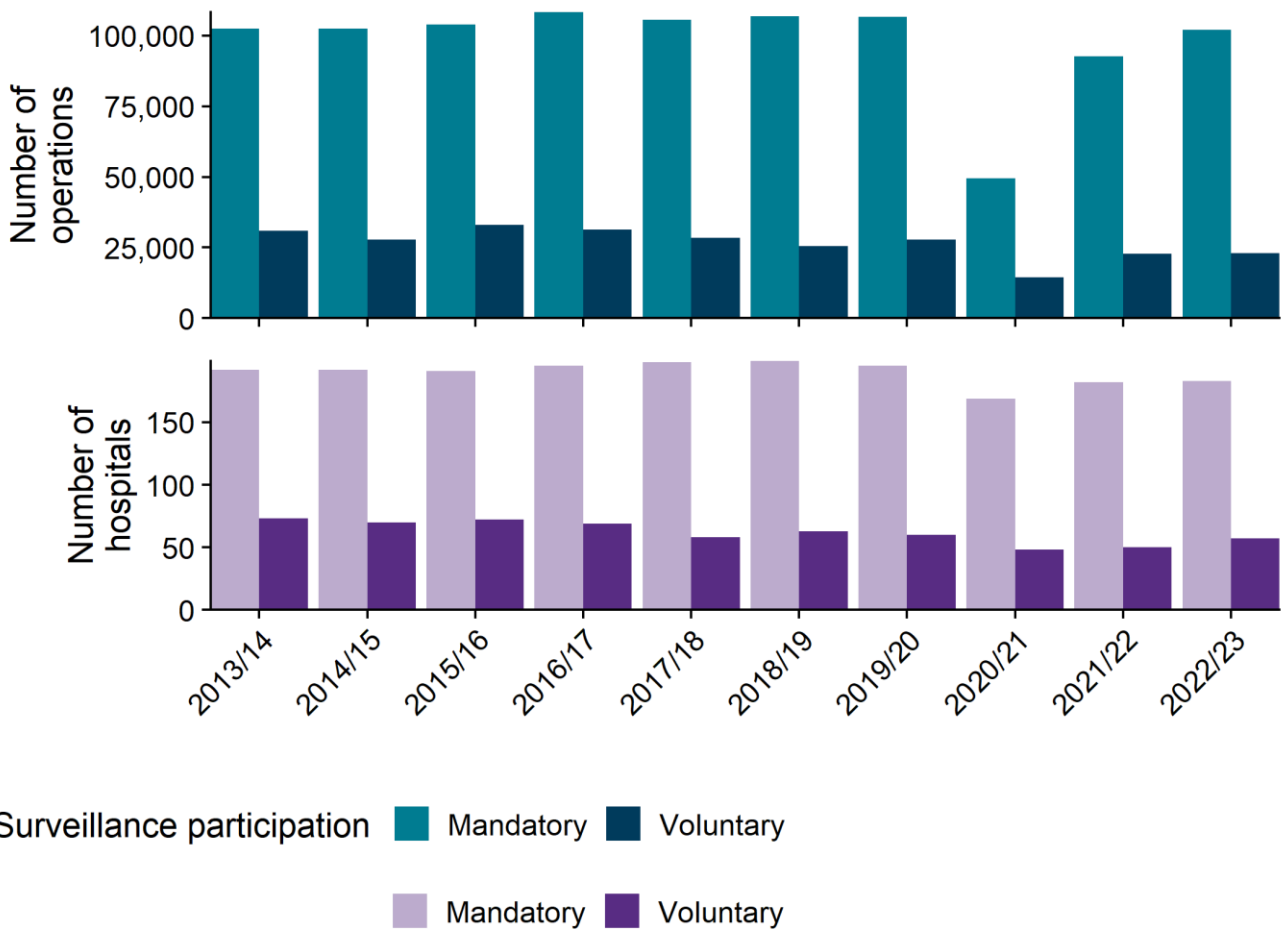
Hospital participation and surgical volumes

Overall, 183 NHS hospitals representing 124 NHS trusts and an additional 8 IS NHS treatment centres participated in the SSISS data collection in the financial year 2022 to 2023. The number of hospitals contributing data remained the same as in 2021 to 2022 and trusts decreased from 125. Surveillance data was submitted for 125,095 procedures and 1,222 SSIs. Of these, 102,025 were orthopaedic procedures submitted as part of mandatory surveillance and 23,070 procedures submitted as part of voluntary surveillance spanning 13 other surgical categories. Compared to financial year 2021 to 2022, the number of operations submitted for mandatory orthopaedic surveillance increased by 10.2% (from 92,608 procedures), while voluntary surveillance showed marginal increase of 1.2% (from 22,804 procedures, [Figure 1](#)), an overall change of 8.4% across all categories.

During the COVID-19 pandemic, hospitals saw a decrease in surgical throughput due to a combination of deferral of non-urgent surgery, cancellations, staff sickness, and reduced operating theatre capacity (11 to 13). The increase in surgical volume submitted to SSISS in financial year 2022 to 2023 (and previously reported in financial year 2021 to 2022) may be due to the increase in capacity for non-urgent surgery. The number of submitted operations was still lower than pre-pandemic (financial year 2019 to 2020) for both mandatory categories (4.3% lower than 106,630 procedures) and voluntary categories (17.2% lower than 27,873 procedures).

Mandatory surveillance requirements mean hip and knee replacement, repair of neck of femur and reduction of long bone fracture surveillance had the highest number of participating hospitals in financial year 2022 to 2023 (150, 138, 75 and 26 hospitals, respectively). Participation in voluntary surgical categories in financial year 2022 to 2023 was highest for large bowel surgery (18 hospitals), followed by breast surgery and spinal surgery (15 and 14 hospitals, respectively).

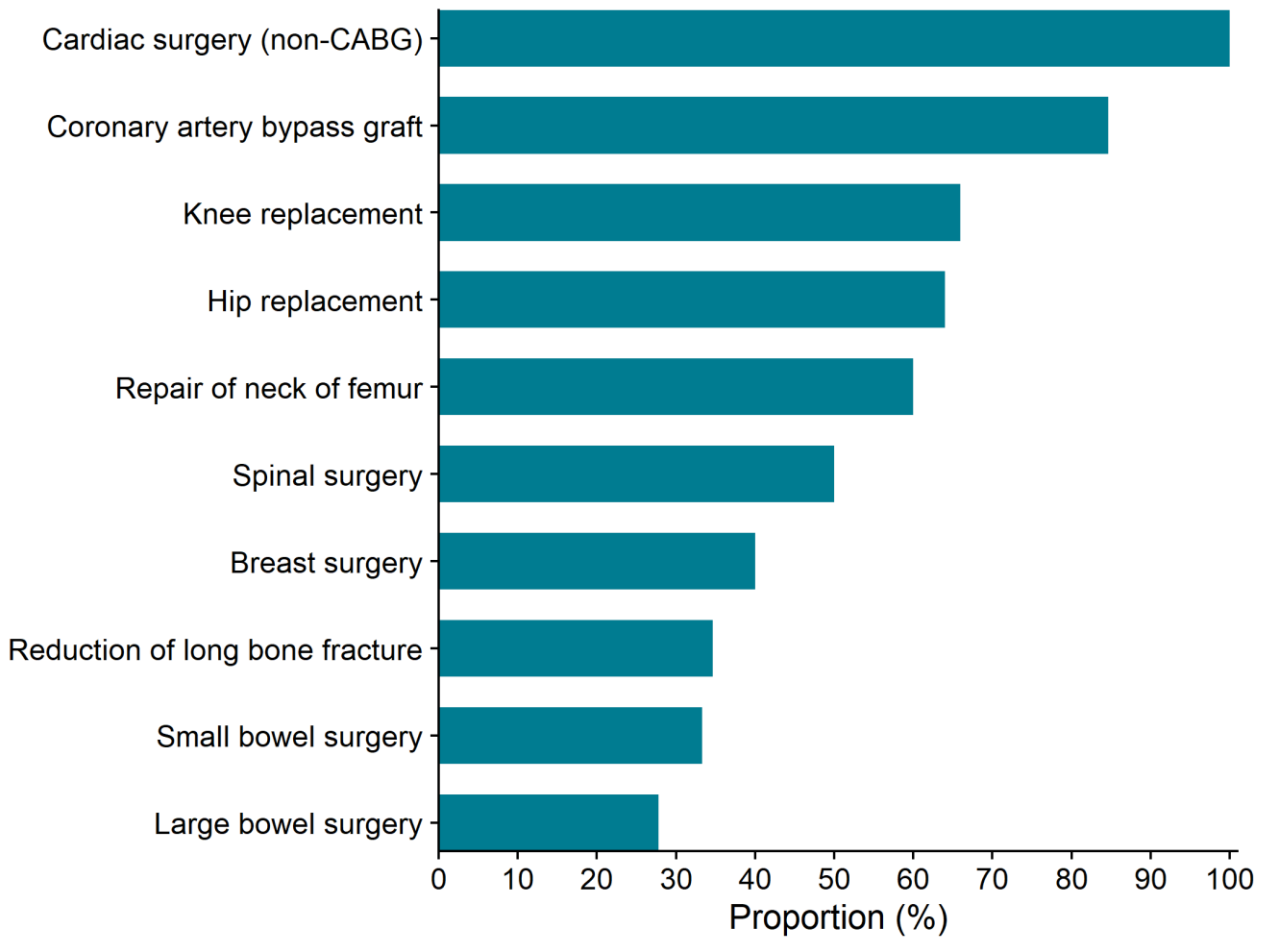
Figure 1. Annual participation in SSISS voluntary and mandatory surveillance, NHS hospitals England, April 2013 to March 2023



[Figure 2](#) shows the proportion of hospitals carrying out continuous surveillance during financial year 2022 to 2023 by surgical category. There were 7 SSISS surgical categories with less than 5 participating hospitals (abdominal hysterectomy, bile duct, liver or pancreatic surgery, cholecystectomy, cranial, gastric, limb amputation, and vascular surgery) which were excluded from this analysis.

Of the voluntary categories, coronary artery bypass graft (CABG) and non-CABG cardiac procedures (open chest procedures on valves or septum of the heart) had the highest proportion of hospitals carrying out continuous surveillance in financial year 2022 to 2023 (84.6% and 100%, respectively). For hip and knee replacement, which are a part of the mandatory surveillance for a minimum of one 3-month surveillance period per financial year (along with reduction of long bone fracture and repair of neck of femur), almost two thirds of hospitals carried out continuous surveillance in financial year 2022 to 2023 (64.0% and 65.9%, respectively). This was comparable to the previous financial year where 65.3% and 63.0% of hospitals undertook continuous surveillance for hip and knee replacement surgery, respectively.

Figure 2. Proportion of hospitals undertaking continuous surveillance, by surgical category, NHS hospitals England, April 2022 to March 2023



Patient and surgical characteristics

[Table 1](#) shows the distribution of key patient and surgical characteristics. Collection of these characteristics is important to help hospitals better understand their results by identifying factors which might be contributing to an increased SSI risk in their patients.

Data completeness for key patient and surgical characteristics was high (equal to or greater than 90%), with most being mandated for collection (see [Appendix 1](#) and [Appendix 2](#)). Data completeness was similar to the previous financial year. Data completeness varied across all surgical categories and patient and surgical-related fields; it ranged from 82.5% to 99.1% in financial year 2022 to 2023, compared to 84.1% to 97.3.4% in financial year 2021 to 2022.

Some variability between categories occurs in the completion of American Society of Anesthesiologists’ (ASA) score, as hospitals may use an alternative assessment score for certain categories (for example cardiac and CABG). Height and weight fields are optional for collection, which means completeness of body mass index (BMI) information was low compared to mandatory fields and varied by category. In financial year 2022 to 2023, BMI was available

for 59.1% of procedures (0.4% higher than financial year 2021 to 2022 (58.9%)). Twelve of 17 surgical categories had BMI data available for 50% or more of those submitted, 6 more than the previous year. As in the previous financial year, cardiac surgeries (CABG and non-CABG) had the most complete BMI information in financial year 2022 to 2023 (84.8% and 82.4%, respectively).

In one of the [previous annual reports](#), we discussed the increase in surgical complexity in financial year 2020 to 2021 compared to financial year 2019 to 2020.

Compared to the previous financial year (2021 to 2022), of the 10 categories assessed, none had consistent increases or decreases in all 4 fields indicating complexity (ASA score, increased surgery duration, patients undergoing multiple operations, increased length of stay); proportional changes were relatively small. The percentage of patients undergoing multiple procedures showed the greatest change from the last financial year. For example, patients undergoing multiple procedures for reduction of long bone fracture increased from 2.5% to 11.0% in financial year 2022 to 2023 compared to 2021 to 2022, and small bowel surgery decreased from 42.6% to 31.4%.

Overall, there was only a marginal difference in median BMI amongst patients undergoing any of the 17 surgical categories between 2022 to 2023 and 2021 to 2022. In financial year 2022 to 2023, knee replacement had the highest proportion of obese (BMI greater than or equal to 30kg/m²) patients among the 17 categories (57.0%), slightly higher than the previous financial year (55.7%). Gastric surgery was the second highest (46.7%) and abdominal hysterectomy third highest (40.0%) ([Appendix 3](#)).

The median patient BMI for hip replacement was 28.4 kg/m² (IQR=25.0-32.5kg/m²) and for knee replacement, 30.9 kg/m² (IQR=27.4 to 34.9 kg/m²); similar to the previous financial year. The median BMI decreased marginally in 11 out of 17 surgical categories. In patients undergoing hip replacement, knee replacement, repair of reduction of long bone fracture and cardiac surgery (non-CABG), the median BMI remained the same or decreased in patients having elective surgery and increased in emergency procedures. However, completion of BMI data is variable by surgical category ([Appendix 2](#)) and by hospital and should be interpreted with caution.

The highest proportion of paediatric (under 18 years) data submitted in 2022 to 2023 was for spinal surgery (11.0% of procedures) followed by small bowel (7.4%), and cardiac (non-CABG) (5.6%); which was comparable to financial year 2021 to 2022 (11.0%, 8.5% and 4.6%, respectively) ([Appendix 3](#)).

Table 1. Patient and surgery-related characteristics by surgical category, NHS hospitals England, April 2022 to March 2023

Surgical category	Patient-related characteristics				Surgery-related characteristics							
	Median age, IQR (years)	Male (%)	BMI ≥ 30 kg/m ² (%)	ASA ≥ 3 (%)	Wound contaminated or dirty (%)	Median surgery duration, IQR (minutes)	Median length of stay, IQR (days)	Pre-op stay more than one day (%)	Emergency surgery (%)	Multiple procedures performed (%)	Antibiotic prophylaxis not given (%)	Implant present (%)
Abdominal hysterectomy*	55 (48-67)	-	40.0	24.3	0.0	142 (103-210.5)	2 (2-5)	1.8	0.0	40.8	2.6	0.0
Bile duct, liver or pancreatic surgery*	65 (56-73)	48.8	-	54.3	0.6	320 (205-459)	8 (5-14)	4.3	0.0	49.4	1.8	4.3
Breast surgery	61 (52-70)	1.3	33.9	15.1	0.0	75 (50-108)	0 (0-1)	0.2	0.2	10.6	6.9	9.5
Cardiac surgery (non-CABG)	65 (53-73)	67.2	29.9	98.7	0.0	250 (201-321)	10 (7-18)	36.8	2.3	42.7	0.1	96.4
Cholecystectomy*	63 (53-71)	47.3	-	42.9	0.5	117 (68-320)	4 (0-10)	7.3	0.0	37.6	0.0	2.0
Coronary artery bypass graft (CABG)	67 (59-74)	83.9	32.9	98.5	0.0	241 (204-287)	9 (7-16)	50.2	1.9	22.2	0.1	82.7
Cranial surgery*	58 (43-68)	51.2	34.1	26.2	2.6	150 (83-243)	5 (3-11)	15.0	7.3	1.7	1.2	38.4
Gastric surgery*	62 (51-72)	52.8	46.7	46.4	6.0	240 (151-386)	7 (3-12)	6.0	0.4	9.9	2.5	1.1
Hip replacement	71 (62-77)	40.0	39.4	31.5	0.1	84 (65-106)	3 (2-5)	4.6	0.2	0.3	4.3	100.0
Knee replacement	70 (63-76)	43.8	57.0	30.4	0.1	80 (62-101)	3 (2-4)	0.7	0.1	0.4	4.9	100.0
Large bowel surgery	66 (55-75)	51.3	28.9	45.3	16.6	194 (140-263)	7 (5-13)	16.3	5.3	21.1	1.9	12.7
Limb amputation*	68 (59-76)	71.1	25.6	92.9	1.6	81 (53-110)	27 (14-39)	72.7	1.6	1.1	0.0	0.5
Reduction of long bone fracture	65 (43-80)	38.7	21.3	44.0	5.1	95 (69-132)	7 (1-18)	34.9	1.0	11.1	6.5	98.2
Repair of neck of femur	84 (77-89)	31.3	9.6	80.9	0.0	70 (55-89)	14 (9-23)	35.6	2.1	0.3	2.8	100.0
Small bowel surgery	62 (45-73)	53.0	25.5	52.1	37.9	120 (81.5-200)	10 (5-19)	30.5	5.6	31.4	1.7	1.5

Surgical category	Patient-related characteristics				Surgery-related characteristics							
	Median age, IQR (years)	Male (%)	BMI ≥ 30 kg/m ² (%)	ASA ≥ 3 (%)	Wound contaminated or dirty (%)	Median surgery duration, IQR (minutes)	Median length of stay, IQR (days)	Pre-op stay more than one day (%)	Emergency surgery (%)	Multiple procedures performed (%)	Antibiotic prophylaxis not given (%)	Implant present (%)
Spinal surgery	56 (38 -69)	46.8	39.1	26.6	0.1	127 (87-188)	3 (1-7)	8.0	2.5	5.6	11.3	43.4
Vascular surgery*	72 (65-7.5)	75.8	25.2	84.6	0.0	190.5 (141-277.5)	3 (1-10)	19.8	4.4	2.5	0.0	75.0

* Surgical categories with fewer than 5 participating hospitals (see [Appendix 2](#)). Results should be interpreted with caution.

Abbreviations

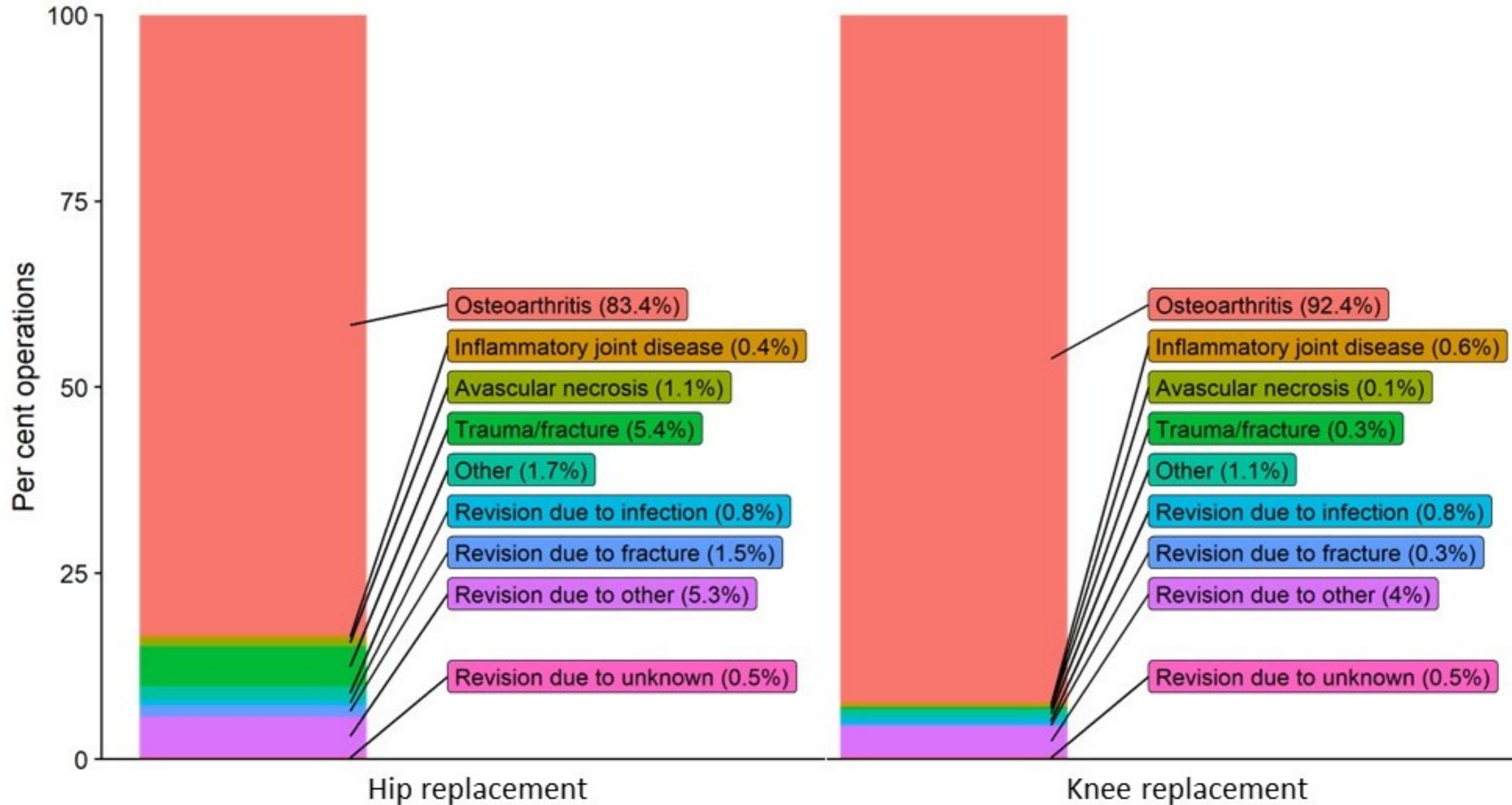
IQR = interquartile range

BMI = body mass index

ASA = American Society of Anesthesiologists

The primary indication for patients undergoing hip and knee replacement is shown in [Figure 3](#). Osteoarthritis continues to be the main reason why patients undergo joint replacement surgery (83.4% for hip; 92.4% for knee). The proportion of replacement surgeries carried out as a result of trauma or fracture decreased by 7.8% for hip and 18.0% for knee from last year (5.4% versus 5.9% and 0.3% versus 0.4%, respectively), a likely reflection of the increase in elective surgeries. The proportion of replacements due to revision decreased for knee (from 6.2% to 5.6%) and remained the same for hip (8.1%) between financial year 2021 to 2022 and 2022 to 2023.

Figure 3. Primary indication for hip replacement (N=38,600*) and knee replacement (N=37,671*) surgery, NHS hospitals England, April 2022 to March 2023



* Total does not include patients who had missing data for primary indication (hip: n=524, knee: n=646)

Assessing SSI risk

Inpatient and readmission SSI risk

[Table 2](#) presents the cumulative SSI incidence (risk) and incidence density by surgical category. Five years of data (April 2018 to March 2023) were used to produce national benchmarks. Inpatient and readmission SSI risk varied greatly depending on the type of surgical procedure.

The highest risk was observed in bile duct, liver or pancreatic surgery at 18.3% (95% CI: 15.7 to 21.1, 15.4% (12.9 to 18.1) in 2022 to 2023; only 3 hospitals participated in this category), followed by large bowel at 8.5% (8.0 to 9.0), then small bowel at 7.8% (6.7 to 9.0). These are procedures carried out at body sites with high levels of bacterial contamination, contributing to a higher risk of SSI. Hip and knee replacement surgery carried the lowest SSI risk (0.5%; (0.4 to 0.5), and 0.4%; (0.35 to 0.41), respectively).

In the current financial year, there were 2 categories with fewer than 5 participating hospitals included in the benchmark. This is the same as in financial year 2021 to 2022, although an increase from previous financial years.

Among the orthopaedic categories, the national benchmark for hip replacement, knee replacement and reduction of long bone fracture all remained the same (0.5%, 0.4% and 0.7%, respectively), while repair of neck of femur decreased (from 0.8% (0.7 to 0.9) to 0.7% (0.7 to 0.8)). For large bowel surgery, which historically ranked highest risk prior to financial year 2019 to 2020, the national benchmark remained high at 8.5% (8.0 to 9.0), in financial year 2022 to 2023 (8.4%; 7.9 to 8.9, in the previous financial year).

For short-stay surgeries (0 to 3 days), such as hip or knee replacement, abdominal hysterectomy, breast, spinal and vascular over half of SSIs were captured through readmission surveillance (ranging from 51.5% to 95.2%) in financial year 2022 to 2023, emphasising the importance of post-discharge surveillance.

SSI incidence density accounts for the differences in length of hospital stay in capturing inpatient SSIs. The incidence density of in-hospital detected SSIs per 1,000 post-operative patient-days varied from 0.1 (0.1 to 0.2) per 1,000 inpatient days for knee replacement to 14.0 (11.7 to 16.7) per 1,000 inpatient days for bile duct, liver or pancreatic surgery. Large bowel surgery had the second highest risk by incidence density (7.2; 6.7 to 7.8, per 1,000 inpatient days) followed by cholecystectomy (7.1; 4.5 to 10.6, per 1,000 inpatient days).

Table 2. Inpatient and readmission SSI risk by surgical category, NHS hospitals England, April 2018 to March 2023

Surgical category	Number of participating hospitals	Number of operations	Inpatient and readmission				Inpatient only		
			Number of SSIs	SSI incidence (%)	95% CI	Median time to infection (days)	Number SSIs	Incidence density (per 1,000 patient days)	95% CI
Abdominal hysterectomy	12	1,102	17	1.5	(0.9-2.5)	11.0	5	1.4	(0.5-3.2)
Bile duct, liver or pancreatic surgery	3	804	147	18.3	(15.7-21.1)	8.0	126	14.0	(11.7-16.7)
Breast surgery	29	13,304	83	0.6	(0.5-0.8)	17.0	4	0.4	(0.1- 1.1)
Cardiac surgery (non-CABG)	12	16,928	198	1.2	(1.0-1.3)	15.0	138	0.7	(0.6-0.8)
Cholecystectomy	3	381	27	7.1	(4.7-10.1)	7.0	23	7.1	(4.5-10.6)
Coronary artery bypass graft	16	27,524	737	2.7	(2.5- 2.9)	15.0	399	1.7	(1.5-1.8)
Cranial surgery	6	6,227	80	1.3	(1.0-1.6)	17.0	32	0.6	(0.4-0.9)
Gastric surgery	8	1,077	24	2.2	(1.4-3.3)	11.5	22	2.3	(1.4-3.5)
Hip replacement	184	174,295	805	0.5	(0.4-0.5)	22.0	187	0.2	(0.2-0.3)
Knee replacement	177	174,124	661	0.4	(0.35-0.41)	24.0	83	0.1	(0.1-0.2)
Large bowel surgery	34	10,527	893	8.5	(8.0-9.0)	8.0	758	7.2	(6.7-7.8)
Limb amputation	6	603	21	3.5	(2.2- 5.3)	8.0	19	1.6	(1.0-2.6)
Reduction of long bone fracture	40	15,487	105	0.7	(0.6-0.8)	20.0	48	0.4	(0.3-0.5)
Repair of neck of femur	113	93,688	696	0.7	(0.7-0.8)	19.0	412	0.3	(0.3-0.3)
Small bowel surgery	14	2,093	163	7.8	(6.7-9.0)	7.0	145	5.5	(4.6-6.5)

Surveillance of surgical site infections in NHS hospitals in England

Surgical category	Number of participating hospitals	Number of operations	Inpatient and readmission				Inpatient only		
			Number of SSIs	SSI incidence (%)	95% CI	Median time to infection (days)	Number SSIs	Incidence density (per 1,000 patient days)	95% CI
Spinal surgery	23	29,950	360	1.2	(1.1-1.3)	15.0	108	0.7	(0.6-0.8)
Vascular surgery	6	3,169	66	2.1	(1.6-2.6)	14.0	32	1.4	(1.0-2.0)

CI = confidence interval

Risk factors for SSI

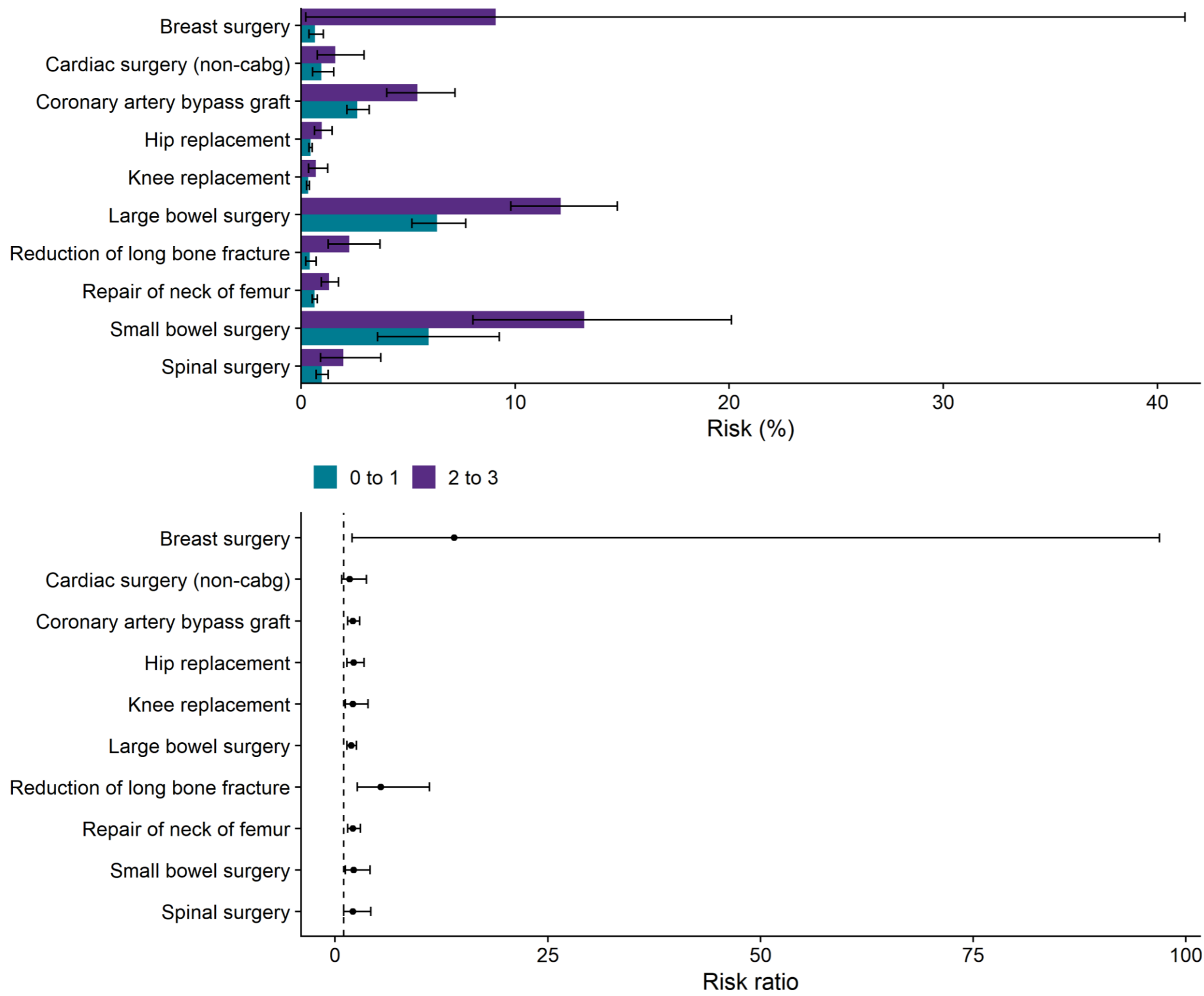
Participants are encouraged to assess their hospital's results stratified by important patient and surgery-related characteristics. The National Healthcare Safety Network (NHSN) risk index is used to account for potentially important differences in patient population. The risk index assigns a cumulative score from 0 to 3 based on the presence of the following risk factors: American Society of Anesthesiologists (ASA) score of 3 or higher, operation duration greater than 'T-time' (as defined by the 75th percentile), and a contaminated or dirty wound.

[Figure 4a](#) shows the SSI risk for financial year 2022 to 2023 across surgical categories for patients whose operation was deemed at low risk of SSI (NHSN risk index 0 or 1) compared to patients with a higher risk of SSI after surgery (risk index 2 or 3).

Risk ratios (RR) were calculated to compare the risk between the 2 groups. A RR greater than 1 indicates an increased SSI risk among those operations with a risk index of 2 or 3 (indicating a high risk) compared to those with a risk index of 0 or 1. Where the confidence intervals do not include the measure of no difference (RR = 1), it is considered unlikely that the observed difference in SSI risk occurred by chance. In all categories of surgery, patients who underwent operations with a higher risk index were more likely to experience infection than those with a lower risk index. For all categories of surgery except cardiac (non-CABG) surgery, the risk ratios were greater than 1 and the corresponding 95% confidence intervals did not overlap 1. However, it is important to note that these risk ratios are still unadjusted measures and have not been adjusted for other factors that might explain the observed increase in relative risk. It is plausible that if these measures were further adjusted to account for other explanatory factors, the risk ratios presented here might change in magnitude, or even in direction.

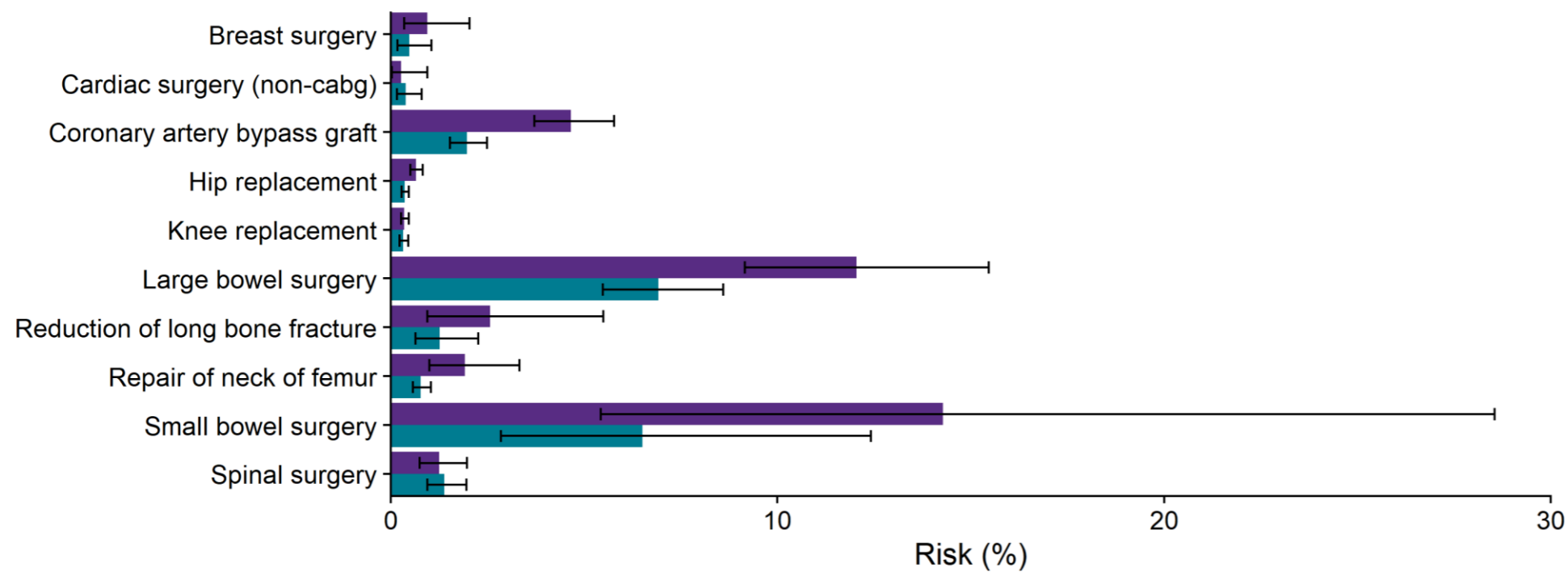
An elevated BMI has been shown to increase the risk of developing an SSI, particularly among CABG patients (14, 15). [Figure 4b](#) shows the unadjusted SSI risk for financial year 2022 to 2023 across surgical categories for patients who are classed as obese (BMI equal to or greater than 30 kg/m²) compared to non-obese patients. In all categories except spinal and cardiac surgery (non-CABG), an increased risk of SSI was seen for the obese patient group relative to the underweight, normal or overweight group.

Figure 4a. Inpatient and readmission SSI risk by NHSN risk index, NHS hospitals England, April 2022 to March 2023*

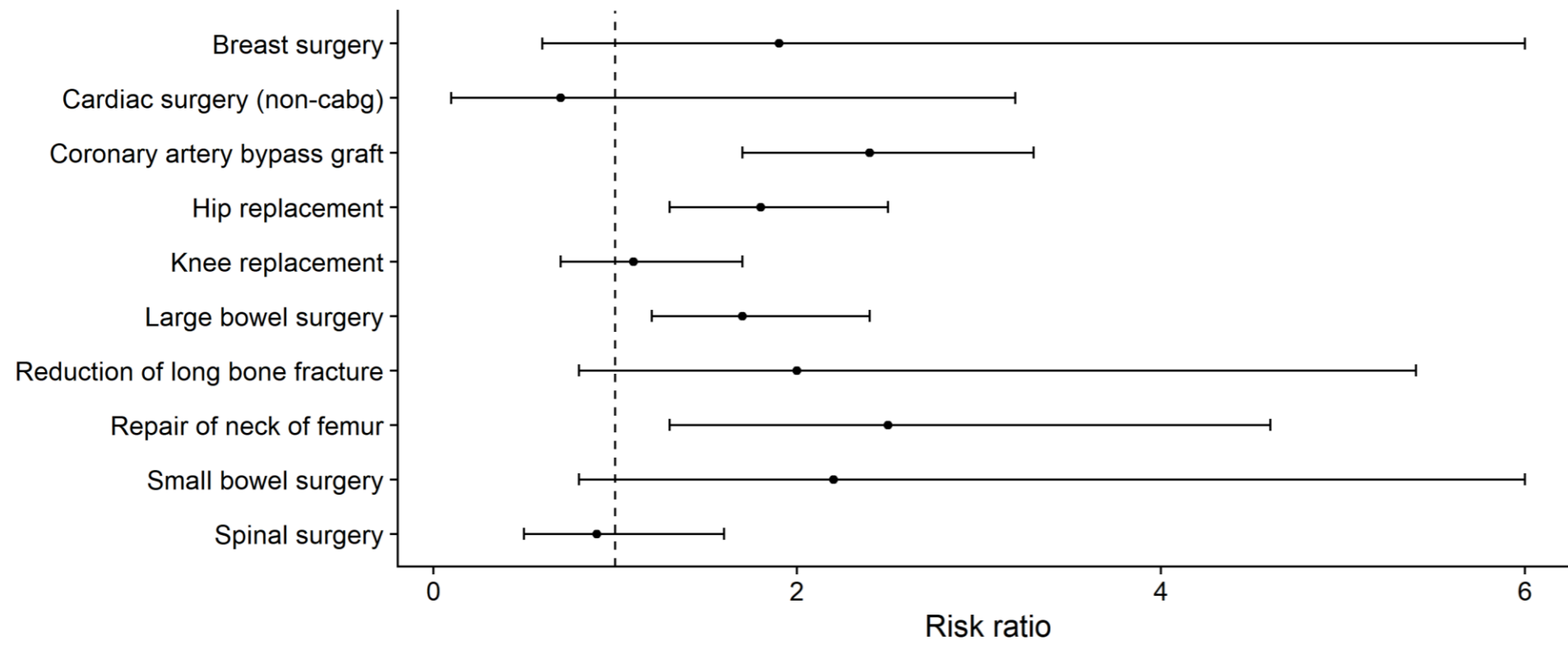


* Categories with less than 5 participating hospitals were excluded.

Figure 4b. Inpatient and readmission SSI risk by patient body mass index, NHS hospitals England, April 2022 to March 2023*



■ BMI < 30 ■ BMI ≥ 30



* Categories with less than 5 participating hospitals were excluded.

[Table 3](#) shows SSI risk by primary indication for hip replacement and knee replacement surgery. For both, hip and knee replacement surgery, revision procedures carried a higher SSI risk than primary procedures (hip: 0.9% (95% CI 0.6 to 1.3) versus 0.4% (0.4 to 0.5), knee: 1.0% (0.6 to 1.5) versus 0.3% (0.3 to 0.4), respectively). The SSI risk for patients undergoing hip replacement due to a fracture decreased from 2.5% (1.3 to 4.3) in 2021 to 2022 to 0.7 % (0.2 to 1.8) in the current financial year.

Table 3. Inpatient and readmission SSI risk by primary indication for joint replacement surgeries, NHS hospitals England, April 2021 to March 2022*

		Hip replacement				Knee replacement			
	Indication for surgery	Number of operations	Number of SSI	SSI risk (%)	95% CI	Number of operations	Number of SSI	SSI risk (%)	95% CI
Primary	Osteoarthritis	32,180	139	0.4	(0.4-0.5)	34,800	98	0.3	(0.2-0.3)
	Inflammatory joint disease	148	0	0.0	(0.0-2.5)	212	1	0.5	(0.0-2.6)
	Avascular necrosis	406	4	1.0	(0.3-2.5)	27	0	0.0	(0.0-12.8)
	Trauma or fracture	2,093	9	0.4	(0.2-0.8)	112	4	3.6	(1.0-8.9)
	Other	663	5	0.8	(0.2-1.8)	429	6	1.4	(0.5-3.0)
	Total		35,490	157	0.4	(0.4-0.5)	35,580	109	0.3
Revision	Infection	322	4	1.2	(0.3-3.1)	306	2	0.7	(0.1-2.3)
	Fracture	564	4	0.7	(0.2-1.8)	106	0	0.0	(0.0-3.4)
	Other	2,047	18	0.9	(0.5-1.4)	1,494	18	1.2	(0.7-1.9)
	Unknown	177	2	1.1	(0.1-4.0)	185	0	0.0	(0.0-2.0)
	Total		3,110	28	0.9	(0.6-1.3)	2,091	20	1.0

* Totals do not include patients who had missing data for primary indication.

CI = confidence interval

Social determinants of health

Ethnicity

The SSI risk by category and ethnic group was based on 5-year data between April 2018 and March 2023. Of the 571,283 operations reported to the SSISS during this period, 2.8% did not link to HES data, while 2.1% had the ethnic group recorded in HES as 'not known' or 'not stated'. During this period, the most commonly reported ethnicity was white (89.27%), followed by Asian, black, other and mixed ethnicity reported in 3.6%, 1.5%, 0.3% and 0.5% of operations, respectively.

[Table 4](#) shows the proportion of patients by ethnic group and surgical category. Across all surgical categories the proportion of white ethnicity ranged from 73% (CABG) to 93% for repair of neck of femur. The proportion of non-white patients varied by surgical category with proportions markedly different for CABG (18.2% Asian patients), cardiac surgery (non-CABG) (8.5% Asian, 3.1% black), cranial surgery (4.9% black), hip replacement (0.9% Asian), knee replacement (5.2% Asian), large bowel surgery (1.3% Asian), repair of neck of femur (1.0 % Asian, 0.3% black), vascular surgery (0.4 Asian, 0.2 black).

[Figures 5a-i](#) show SSI risk ([Appendix 4](#)) and Risk Ratios to compare the risk between ethnic groups (using white ethnicity as the reference group) for categories with more than 5 hospitals participating during the 5-year period. These comparisons lack statistical power due to the very low surgical volumes in some of the non-white ethnic groups ([Table 4](#)). Therefore, care should be taken when interpreting these results. The risk ratios are also unadjusted estimates, which means the estimates do not account for other factors which may play a role in explaining some of the differences.

There was some evidence that black ethnicity was associated with increased SSI risk in reduction for long bone fracture (RR 3.15, 95% CI 1.17 to 8.49). Despite the very wide confidence intervals which only just include the measure of no effect (1.0), there was some suggestion that the SSI risk in breast surgery was slightly higher in the Mixed ethnic group (RR 3.63; 0.91 to 14.52) ([Figure 5f](#)). There was also some evidence that SSI risk in knee replacement was slightly lower in the Asian ethnic group (RR 0.62; 0.41 to 0.95) ([Figure 5b](#)) compared to people of white ethnicity.

There was no evidence for differences in SSI risk by ethnicity for other categories of surgery and it is likely that these analyses were affected by the low numbers of operations when stratified by ethnic group as described in the [Table 4](#). Results for Other ethnicity group should be also interpreted with caution due to this being a heterogeneous group including dissimilar groups of people when looking at more granular level (2021 Census lists 68 subcategories for the Other high-level ethnic group).

Table 4. Patient distribution by ethnic group and surgical category, NHS hospitals England, April 2018 to March 2023

Surgical category	Asian number (%)	Black number (%)	Other ethnicity number (%)	Mixed or multiple ethnicity number (%)	White number (%)	Missing or unknown number (%)	Total number (%)
Abdominal hysterectomy	37 (3.4)	36 (3.3)	9 (0.8)	12 (1.1)	953 (86.5)	55 (5.0)	1,102 (100)
Bile duct, liver or pancreatic surgery	19 (2.3)	12 (1.5)	1 (0.1)	7 (0.9)	729 (89.8)	44 (5.4)	812 (100)
Breast surgery	307 (2.3)	165 (1.2)	35 (0.3)	85 (0.6)	11,712 (88.0)	1,001 (7.52)	13,305 (100)
Cardiac surgery (non-CABG)	1,430 (8.5)	517 (3.1)	109 (0.6)	149 (0.9)	13,611 (80.4)	1,114 (6.6)	16,930 (100)
Cholecystectomy	11 (2.9)	6 (1.6)	2 (0.5)	2 (0.5)	327 (85.8)	33 (8.7)	381 (100)
Coronary artery bypass graft	5,002 (18.2)	508 (1.8)	251 (0.91)	228 (0.83)	20,106 (73.0)	1,465 (5.3)	27,560 (100)
Cranial surgery	290 (4.7)	305 (4.9)	46 (0.7)	76 (1.2)	5,191 (83.4)	319 (5.1)	6,227 (100)
Gastric surgery	15 (1.4)	16 (1.5)	2 (0.2)	11 (1.0)	948 (87.9)	86 (8.0)	1,078 (100)
Hip replacement	1,506 (0.9)	2,137 (1.2)	346 (0.2)	641 (0.4)	160,666 (92.2)	9,003 (5.2)	174,299 (100)
Knee replacement	8,995 (5.2)	3,444 (2.0)	428 (0.3)	778 (0.5)	153,450 (88.1)	7,031 (4.0)	174,126 (100)
Large bowel surgery	140 (1.33)	97 (0.9)	32 (0.3)	64 (0.6)	9,494 (90.1)	708 (6.7)	10,535 (100)
Limb amputation	14 (2.3)	11 (1.8)	0 (0.0)	1 (0.2)	548 (90.9)	29 (4.8)	603 (100)
Reduction of long bone fracture	273 (1.8)	188 (1.2)	97 (0.6)	104 (0.7)	13,928 (98.9)	897 (5.8)	15,487 (100)
Repair of neck of femur	939 (1.0)	321 (0.3)	191 (0.2)	233 (0.3)	87,320 (93.2)	4,689 (5.0)	93,693 (100)
Small bowel surgery	63 (3.0)	37 (1.8)	11 (0.5)	18 (0.9)	1,859 (88.7)	108 (5.2)	2,096 (100)
Spinal surgery	1,232 (4.1)	866 (2.9)	110 (0.4)	321 (1.1)	26,267 (87.7)	1,155 (3.9)	29,951 (100)
Vascular surgery	14 (0.4)	7 (0.2)	8 (0.3)	17 (0.5)	2,957 (93.3)	166 (5.2)	3,169 (100)

Figure 5a. Risk of SSI in patient undergoing hip replacement by ethnic group, NHS hospitals England, April 2018 to March 2023

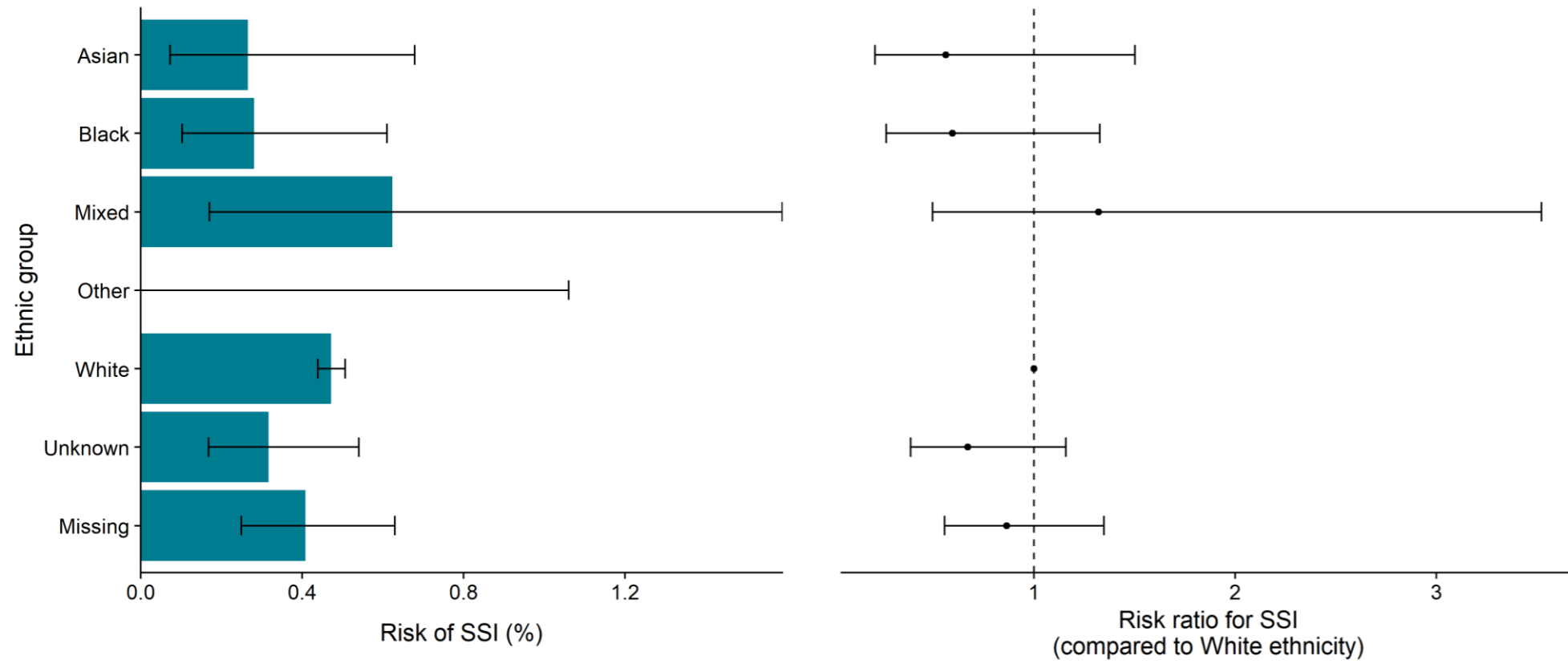


Figure 5b. Risk of SSI in patient undergoing knee replacement by ethnic group, NHS hospitals England, April 2018 to March 2023

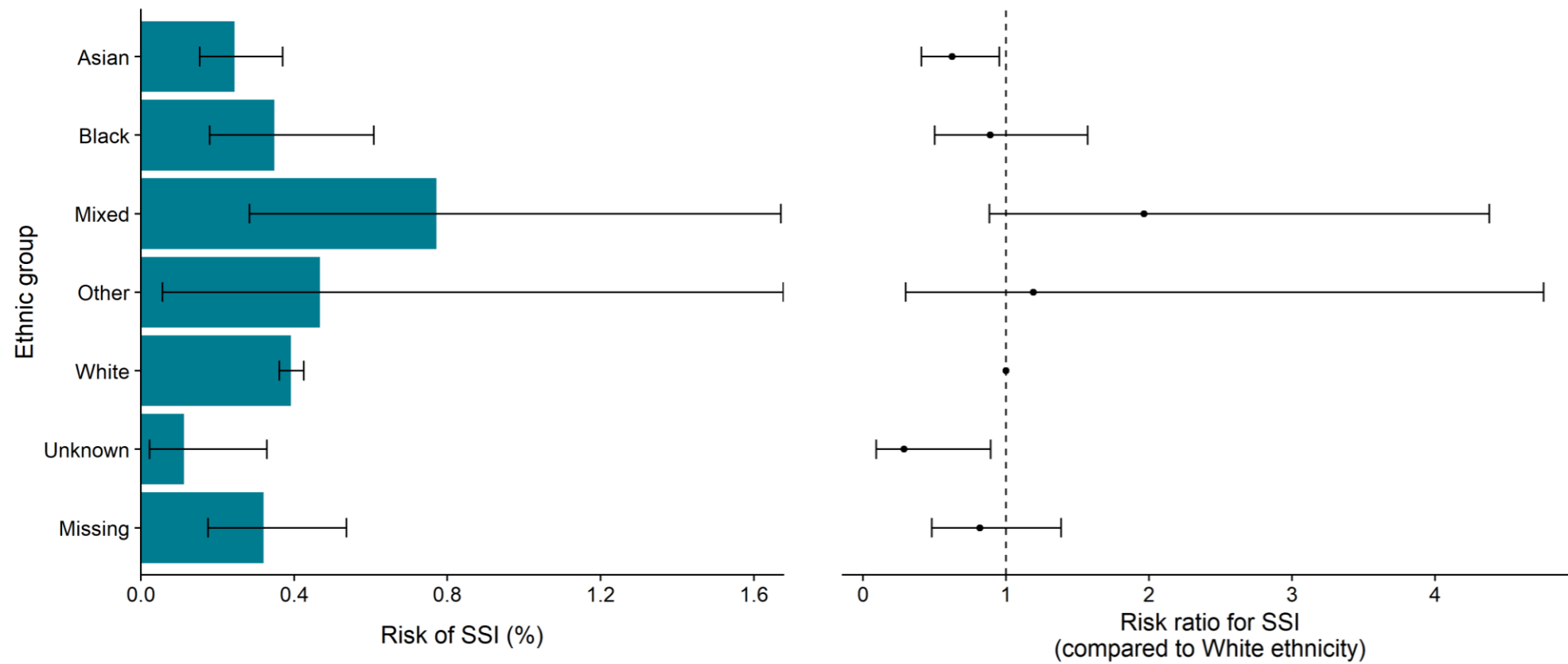


Figure 5c. Risk of SSI in patient undergoing reduction of long bone fracture by ethnic group, NHS hospitals England, April 2018 to March 2023

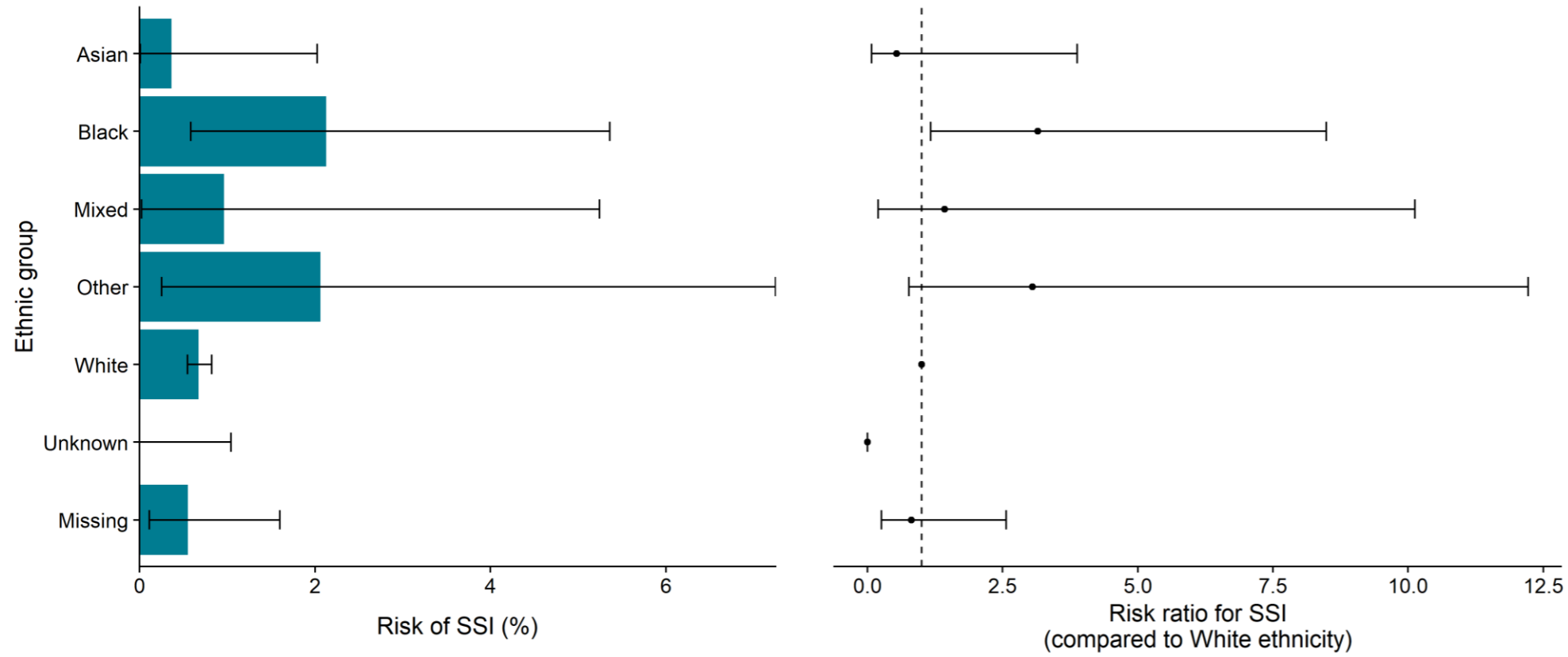


Figure 5d. Risk of SSI in patient undergoing repair of neck of femur by ethnic group, NHS hospitals England, April 2018 to March 2023

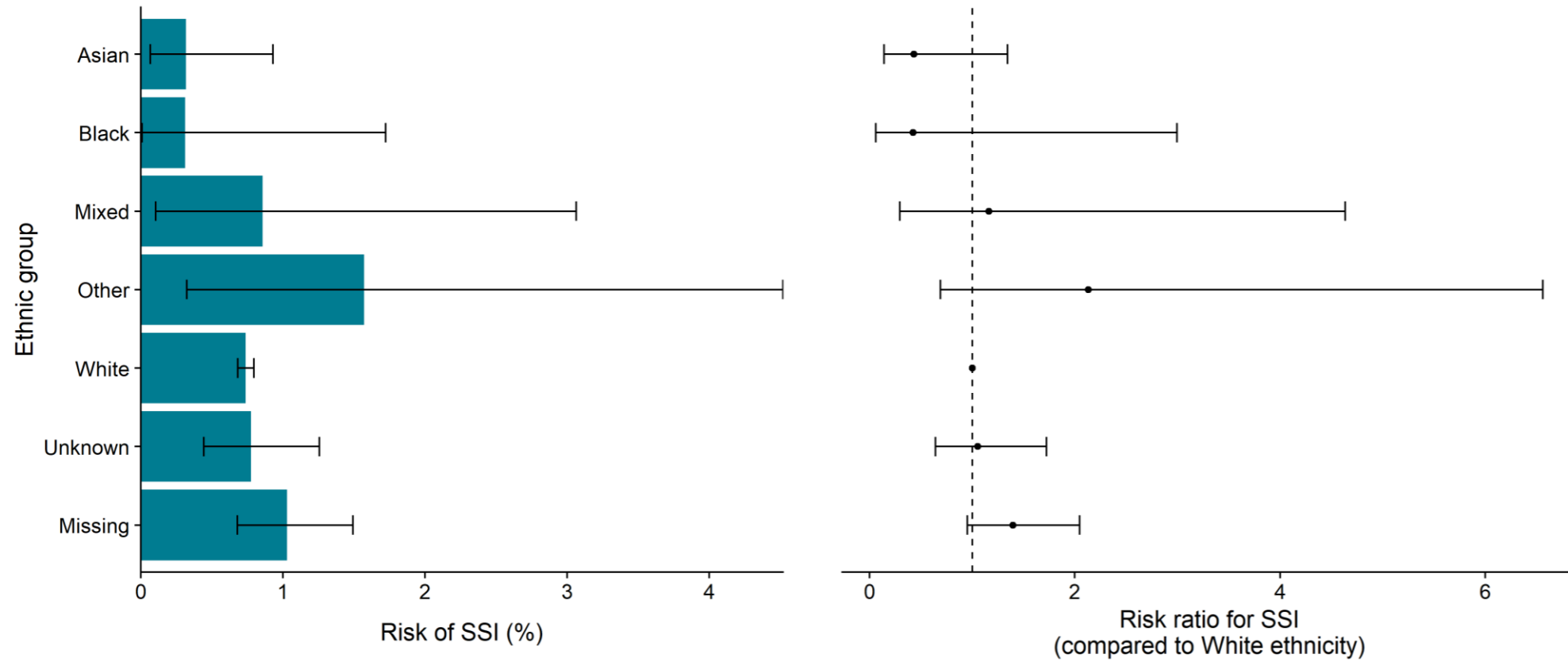


Figure 5e. Risk of SSI in patient undergoing large bowel surgery by ethnic group, NHS hospitals England, April 2018 to March 2023

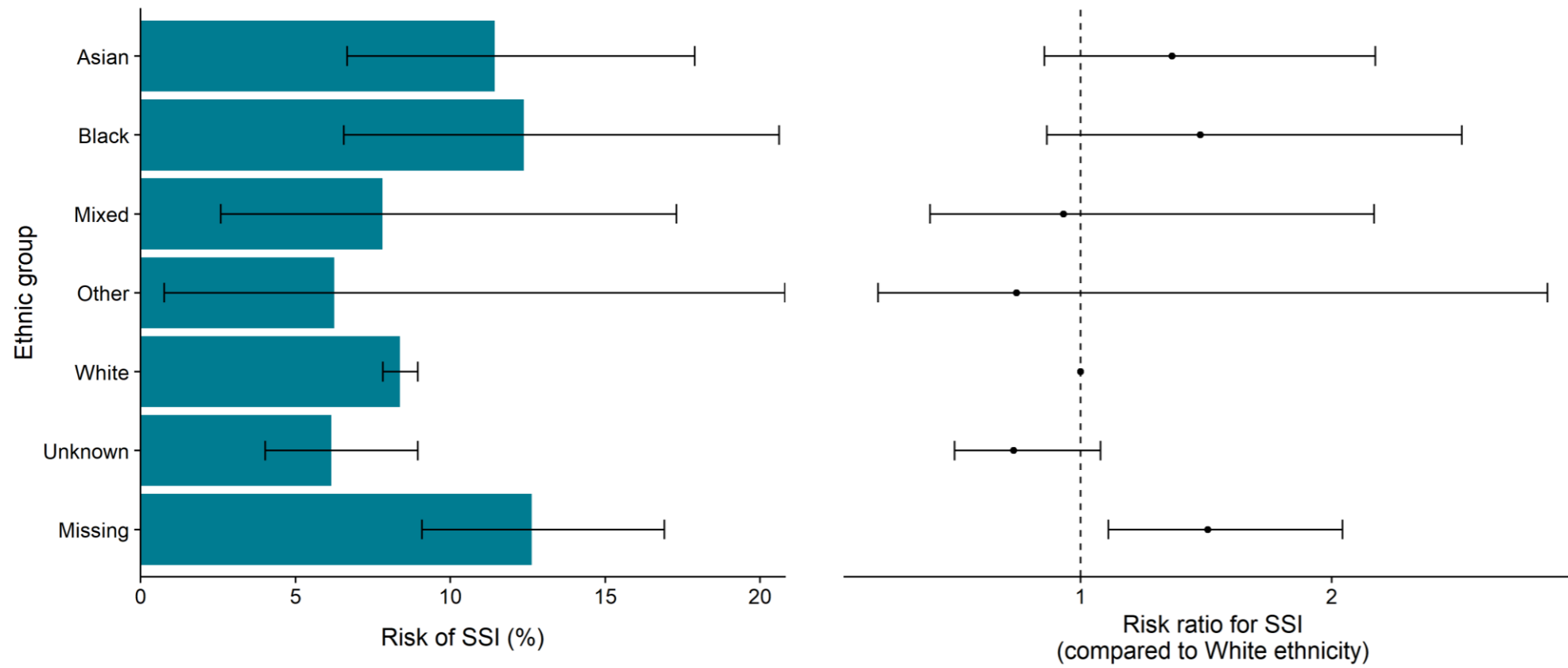


Figure 5f. Risk of SSI in patient undergoing breast surgery by ethnic group, NHS hospitals England, April 2018 to March 2023

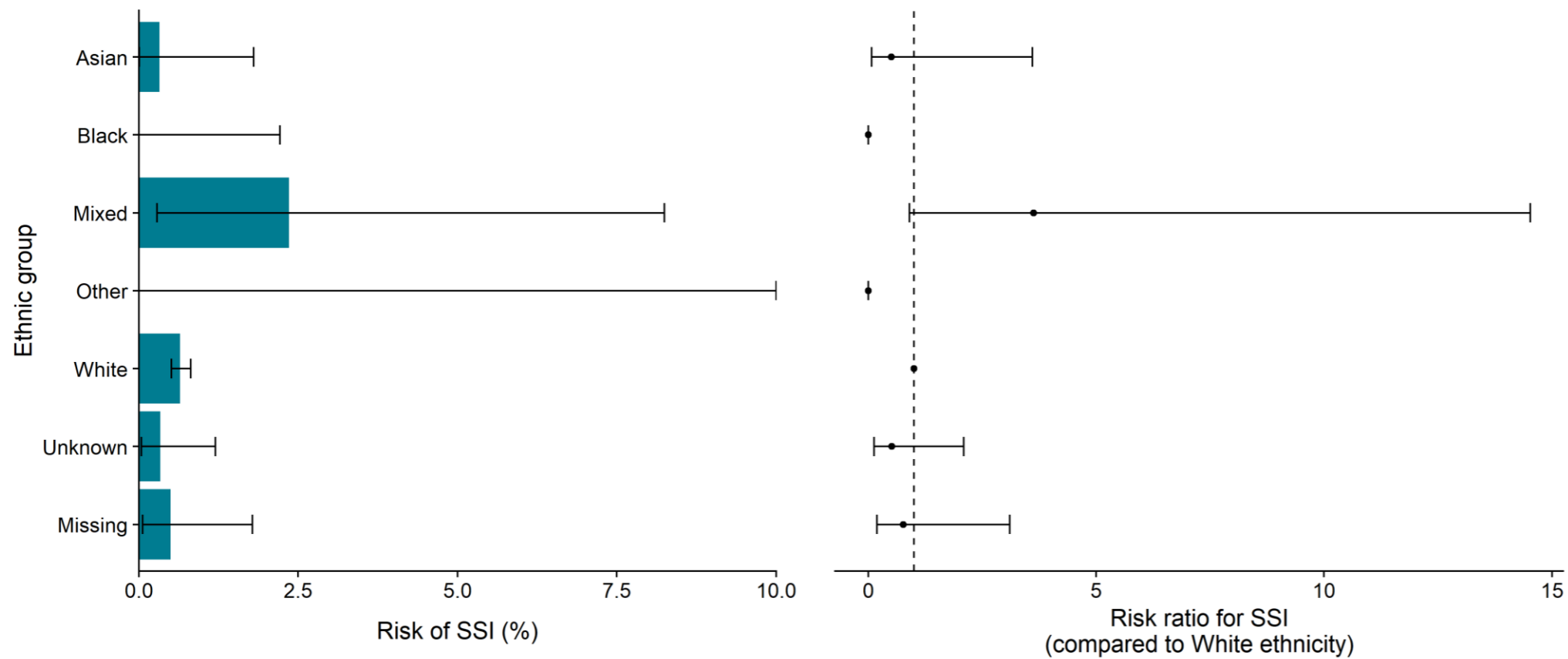


Figure 5g. Risk of SSI in patient undergoing cardiac surgery (non-CABG) by ethnic group, NHS hospitals England, April 2018 to March 2023

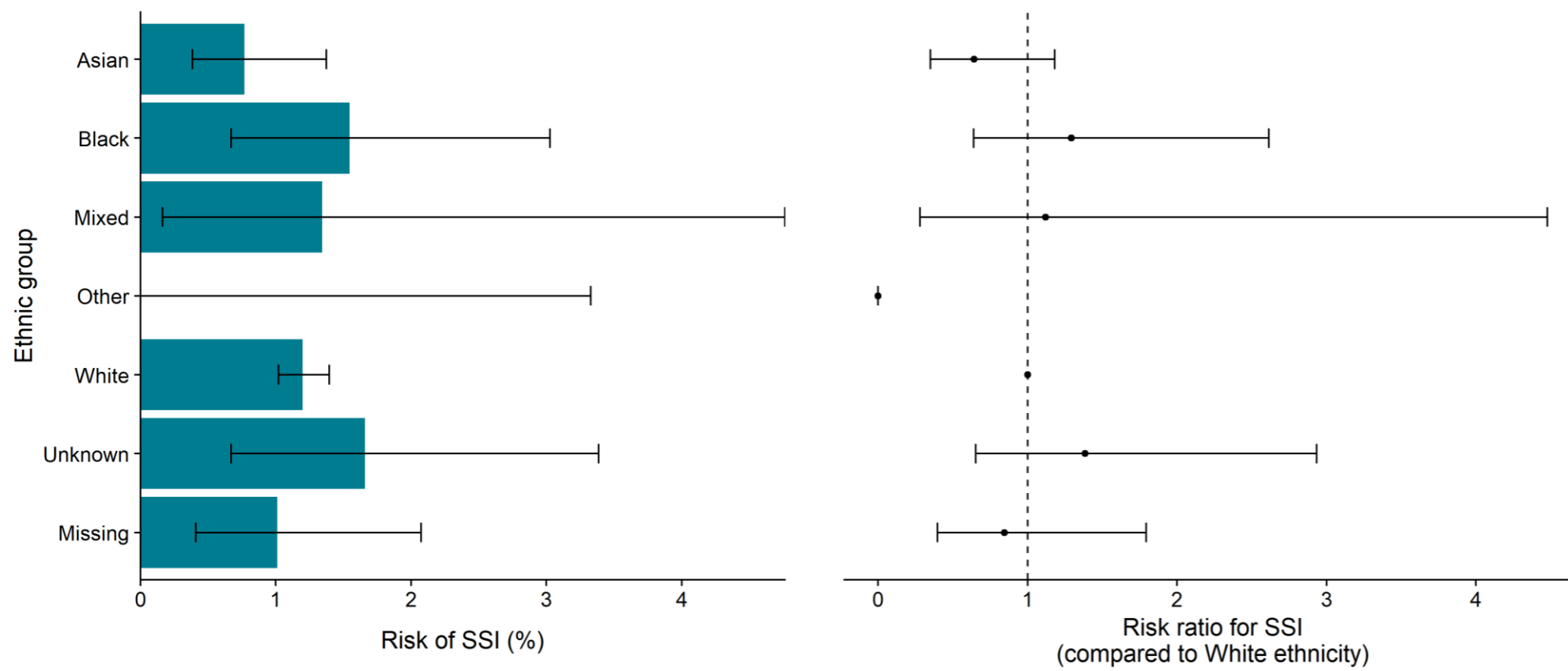


Figure 5h. Risk of SSI in patient undergoing CABG by ethnic group, NHS hospitals England, April 2018 to March 2023

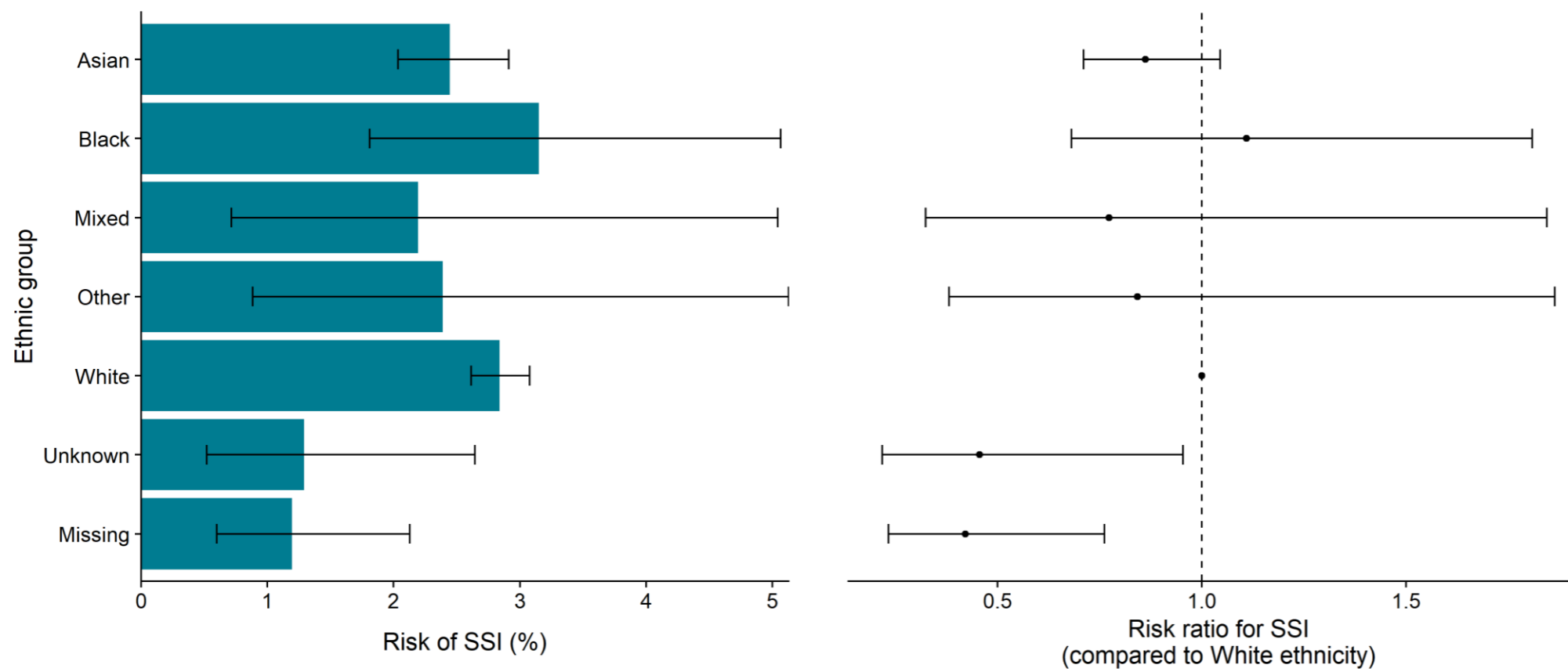
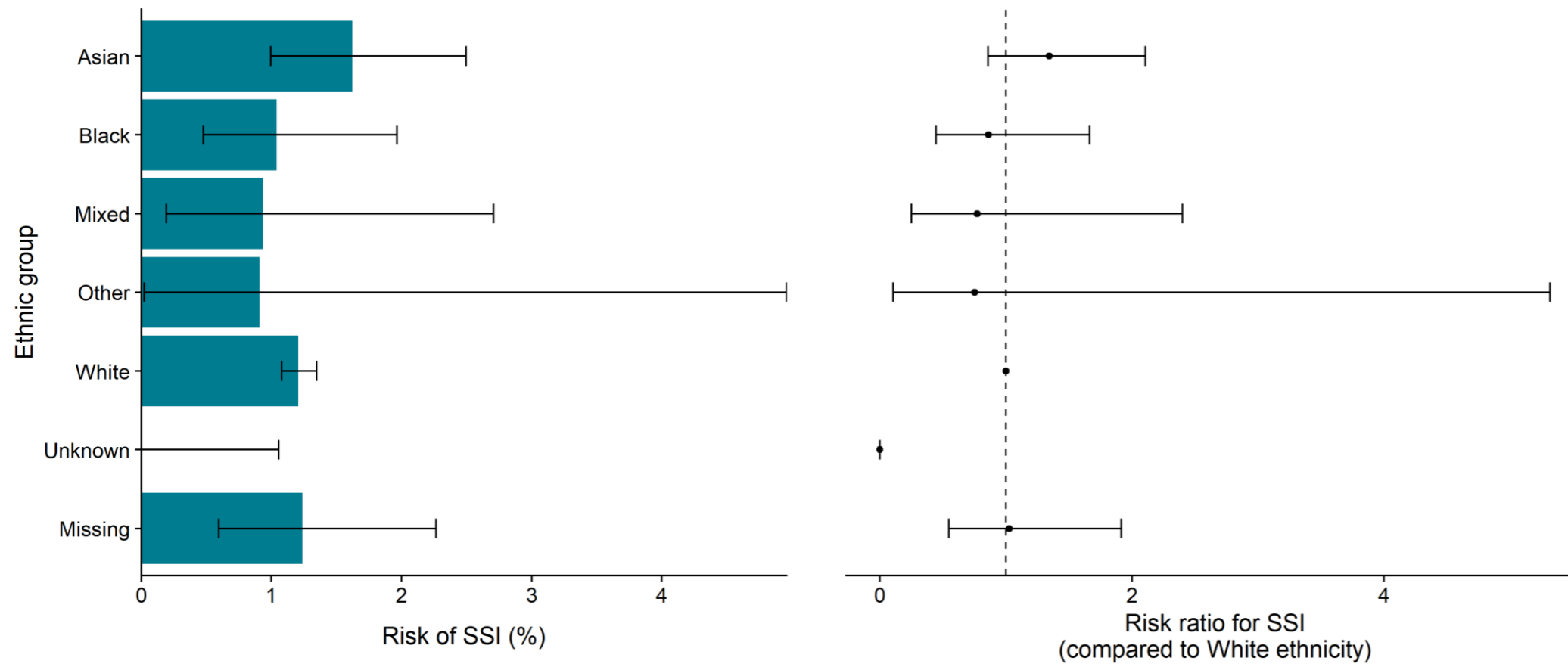


Figure 5i. Risk of SSI in patient undergoing spinal surgery by ethnic group, NHS hospitals England, April 2018 to March 2023



IMD

The proportion of records with missing IMD score fluctuated by surgical category between 1.8% for gastric surgery and 8.0% for abdominal hysterectomy ([Appendix 5](#)).

[Figures 6a-i](#) show SSI risk by IMD deciles in a selection of surgical categories based on hospital participation (minimum of 5 hospitals submitted data in the current financial year). Overall, the risk of SSI was higher in deciles representing higher deprivation with 6 of the displayed surgical categories having the highest SSI risk in the most deprived decile (knee replacement, reduction of long bone fracture, large bowel surgery, breast surgery, cardiac surgery (non-CABG) and CABG).

There was a high degree of variation in the risk of SSI by deprivation decile group. While, overall, there were higher risks of SSI among people resident in areas with greater relative deprivation, there were exceptions to this in some decile groups for both hip and knee replacements. For example, the second least deprived decile group (decile group 9) for hip replacement had a higher risk of SSI than the fourth most deprived decile group (decile group 4).

In contrast, the risk of SSI among patients undergoing small bowel surgery was higher among patients resident in areas of low relative deprivation than among patients resident in areas of high relative deprivation. For reduction of long bone fracture and repair of neck of femur, the SSI risk appeared to be higher in most and least deprived deciles (reduction of long bone fracture; deciles 1, 2, 7, 10; repair of neck of femur: deciles 1 and 10) and lower in between.

As observed for the SSI risk by ethnicity, the confidence intervals for SSI risk by IMD deciles for all surgical categories overlapped indicating larger uncertainty around true difference between deciles ([Appendix 6](#)).

Figure 6a. Risk of SSI in patients undergoing hip replacement by IMD decile, NHS hospitals England, April 2018 to March 2023

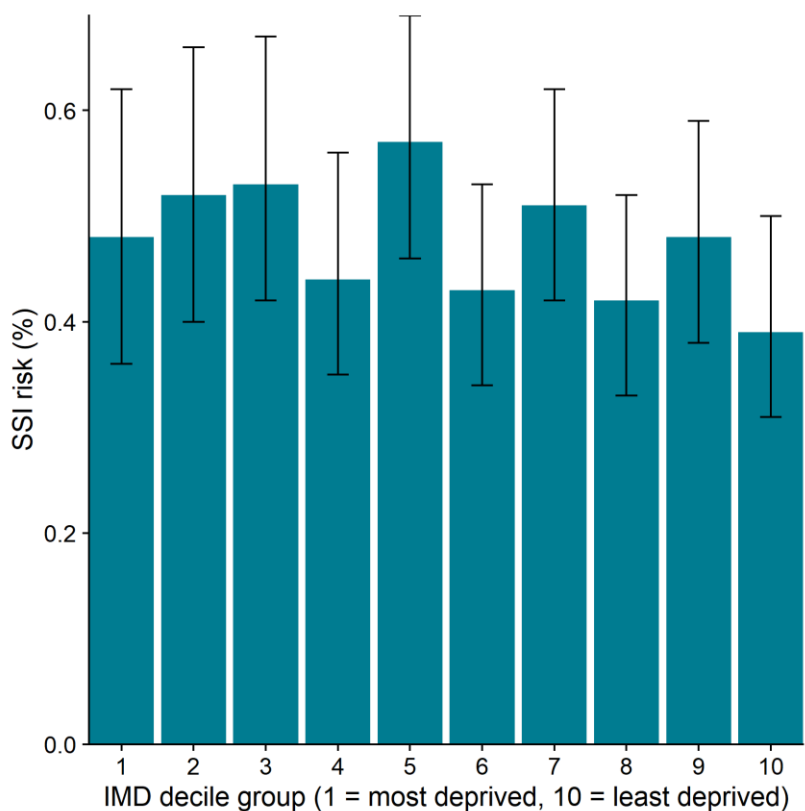


Figure 6b. Risk of SSI in patients undergoing knee replacement by IMD decile, NHS hospitals England, April 2018 to March 2023

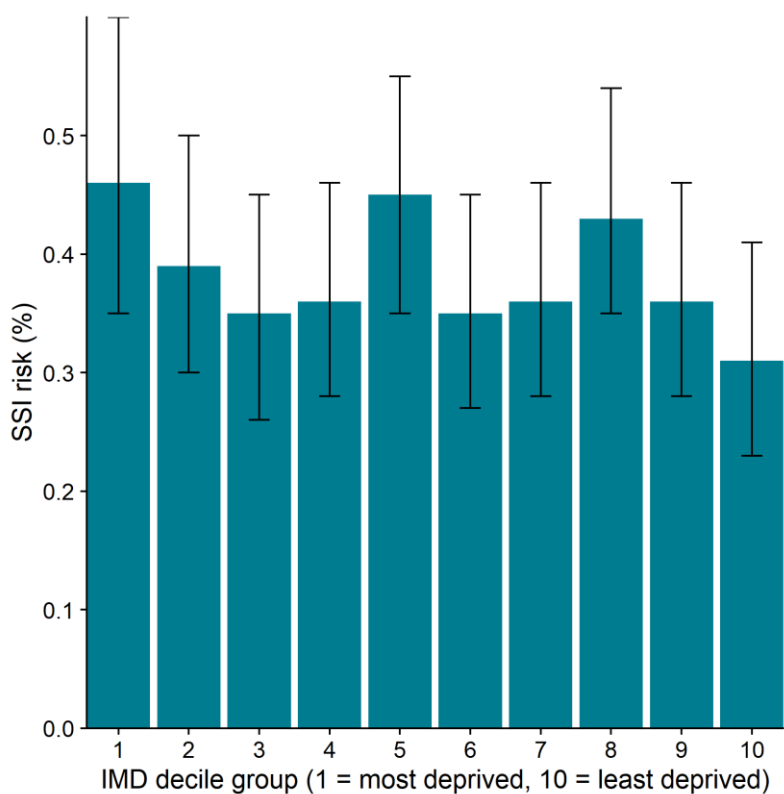


Figure 6c. Risk of SSI in patients undergoing reduction of long bone fracture by IMD decile, NHS hospitals England, April 2018 to March 2023

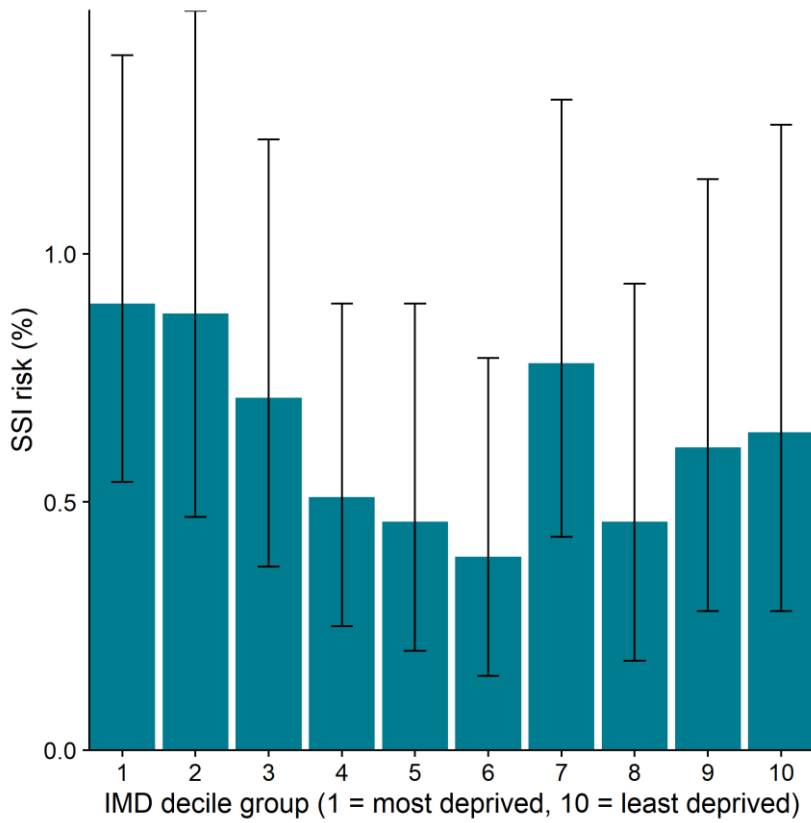


Figure 6d. Risk of SSI in patients undergoing repair of neck of femur by IMD decile, NHS hospitals England, April 2018 to March 2023

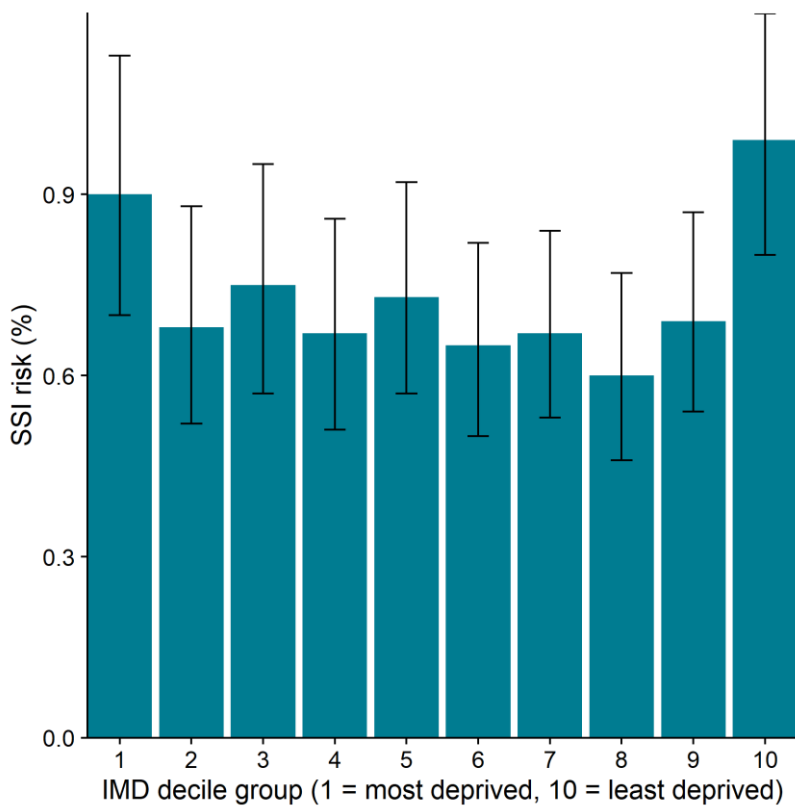


Figure 6e. Risk of SSI in patients undergoing large bowel surgery by IMD decile, NHS hospitals England, April 2018 to March 2023

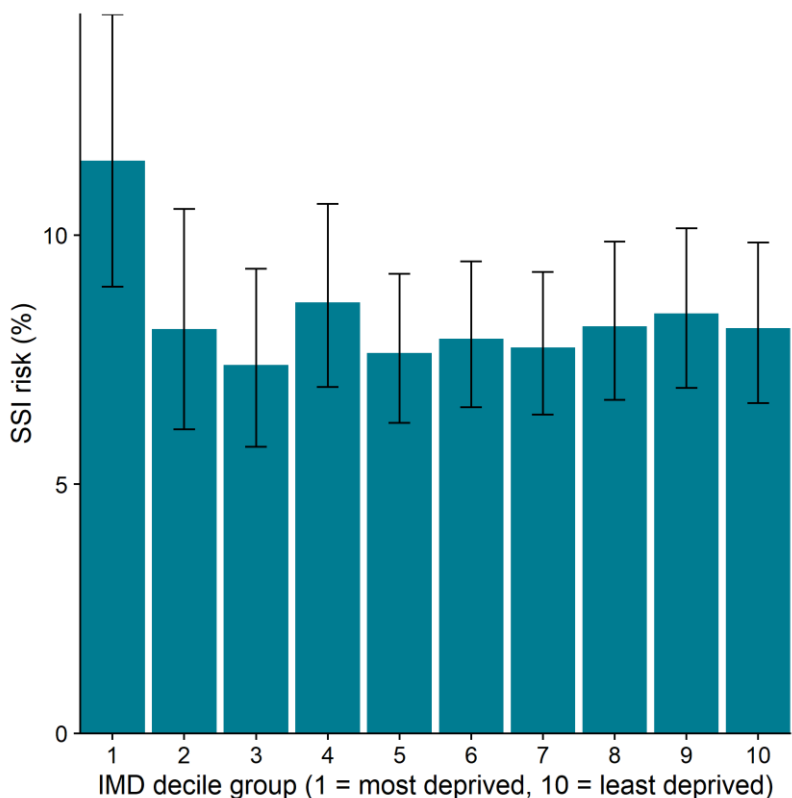


Figure 6f. Risk of SSI in patients undergoing breast surgery by IMD decile, NHS hospitals England, April 2018 to March 2023

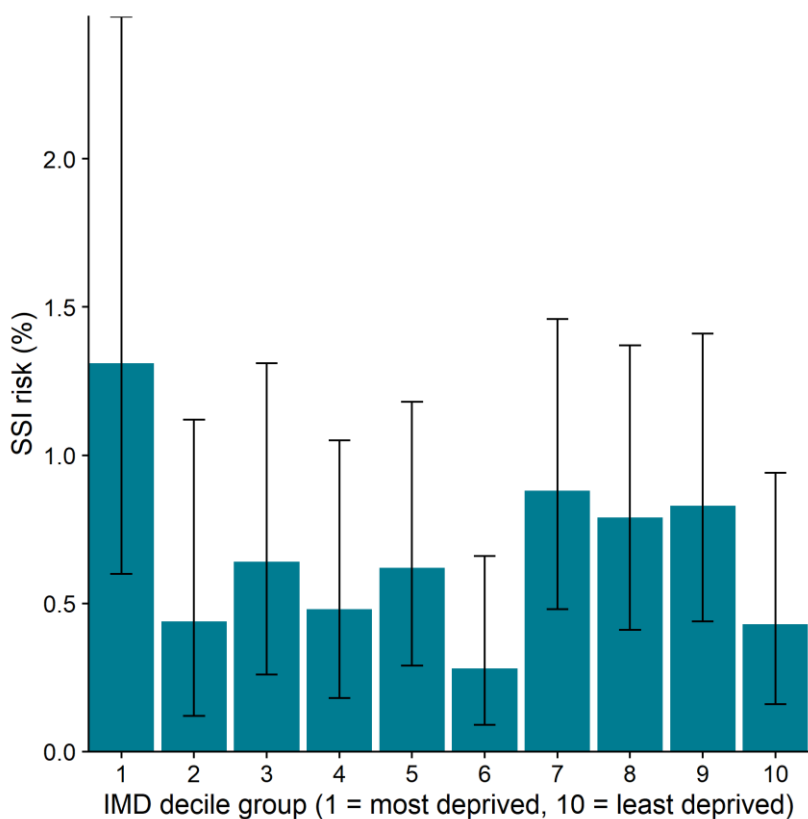


Figure 6g. Risk of SSI in patients undergoing cardiac surgery (non-CABG) by IMD decile, NHS hospitals England, April 2018 to March 2023

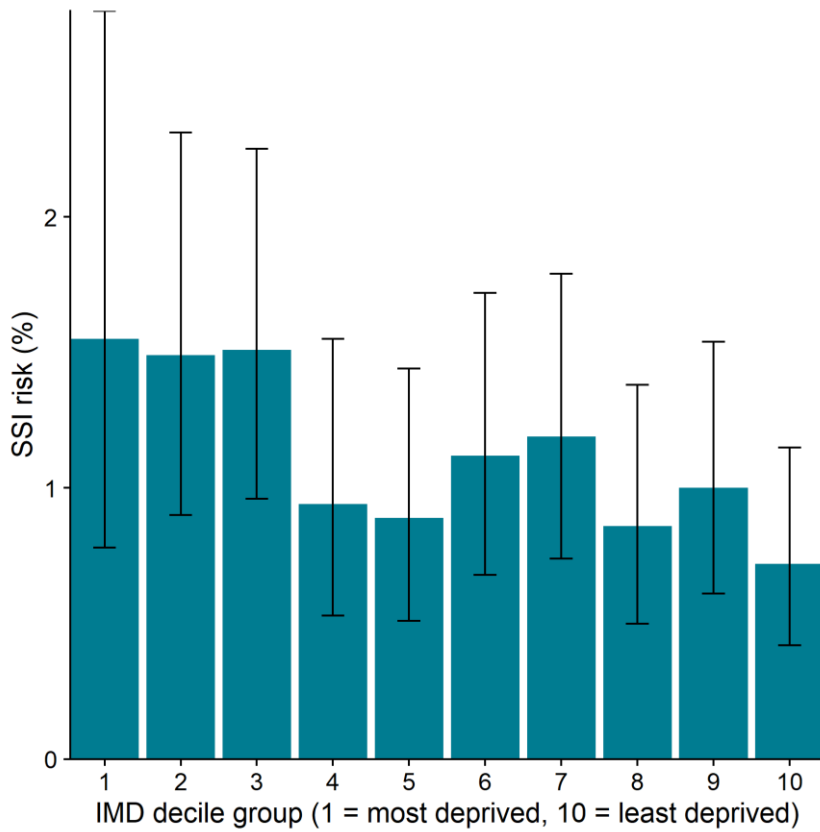


Figure 6h. Risk of SSI in patients undergoing CABG surgery by IMD decile, NHS hospitals England, April 2018 to March 2023

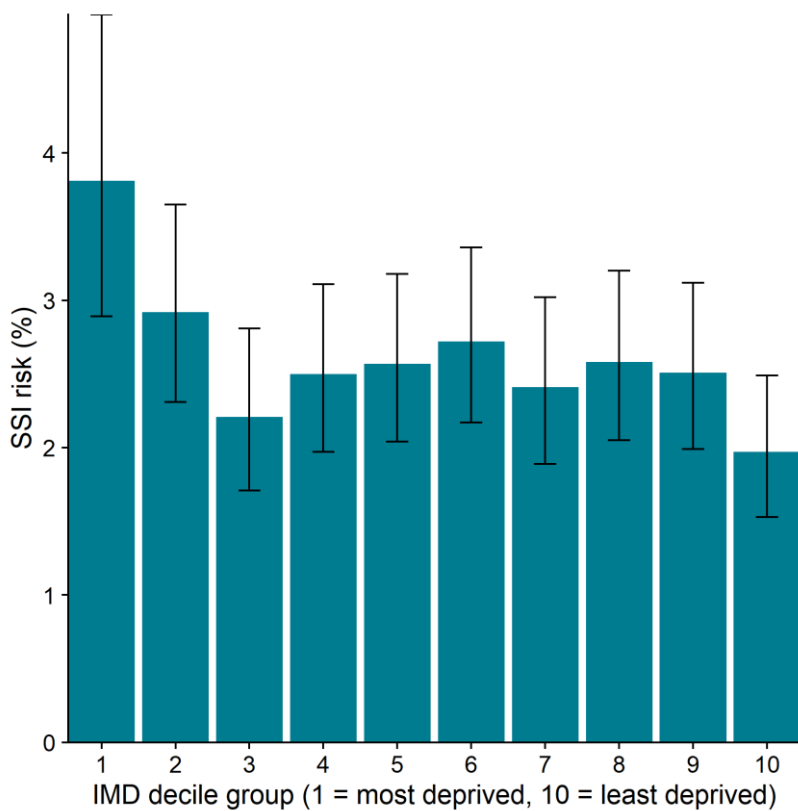


Figure 6i. Risk of SSI in patients undergoing spinal surgery by IMD decile, NHS hospitals England, April 2018 to March 2023

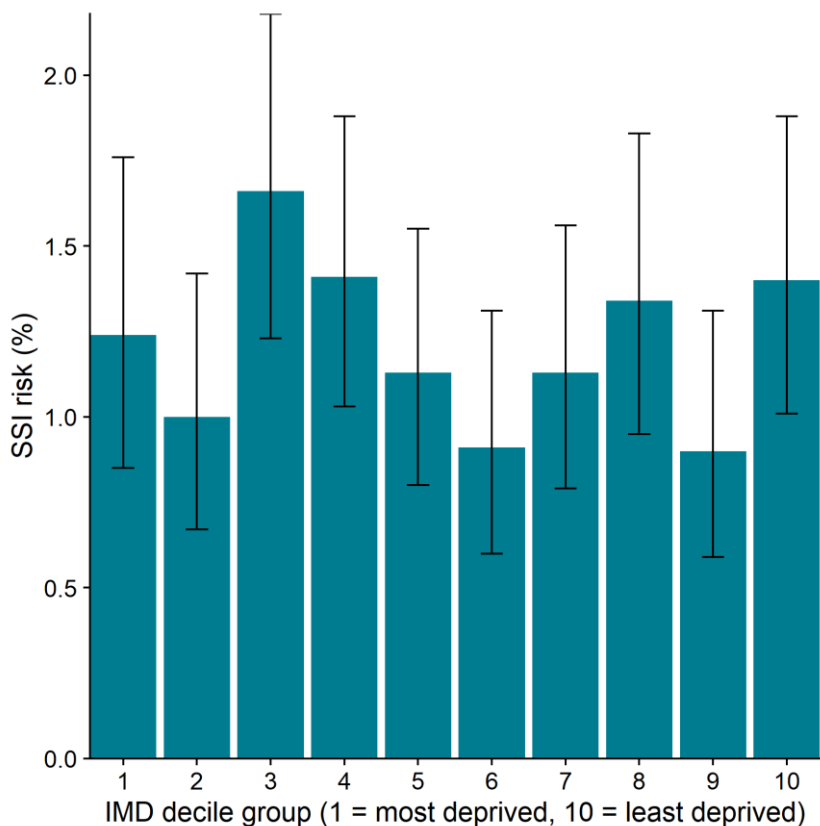
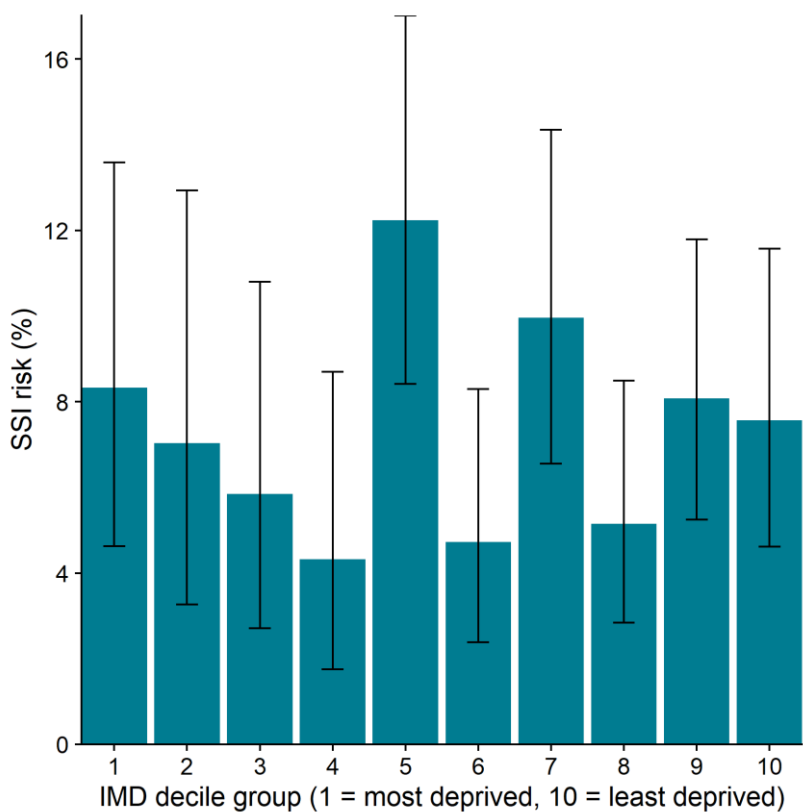


Figure 6j. Risk of SSI in patients undergoing small bowel surgery by IMD decile, NHS hospitals England, April 2018 to March 2023



Trends in SSI risk

[Figures 7a-j](#) show 10-year trends in annual SSI incidence (risk) for all surgical categories. SSI incidence is broken down by detection method: inpatient, readmission and combined inpatient and readmission. Trend analyses were not performed for surgical categories with fewer than 5 participating hospitals in the most recent financial year. It is important to note that annual trends use crude SSI incidence and do not account for potential changes in risk factors for SSI over time, hospital participation or other factors affecting healthcare delivery such as length of inpatient stay.

Over the past 10 years, inpatient and readmission SSI incidence following hip and knee replacement surgery has been relatively stable, with slight annual decreases from financial year 2013 to 2014 ([Figure 7a](#) and [Figure 7b](#)). In the current financial year, SSI risk remained stable for hip replacement (0.48%; 0.41 to 0.55) and knee replacement (0.34%; 0.28 to 0.40) in comparison to the previous financial year. The trend for the inpatient and readmission SSI risk following reduction of long bone fracture has shown greater variability over the years ([Figure 7c](#)). After a peak in financial year 2014 to 2015 at 1.40% (0.95 to 2.00), the rate showed a decreasing trend; however, since last year it has shown an increase from 0.54% to 0.76% (0.51 to 1.07). Repair of neck of femur ([Figure 7d](#)) has seen an overall continuous decline in SSI risk since financial year 2013 to 2014 (1.14% (0.99 to 1.30) and despite some upward trend since the financial year 2021 to 2022, the SSI risk still remains lower at 0.80% (0.68 to 0.93) in 2022 to 2023.

[Figure 7e](#) shows an overall decreasing 10-year trend for CABG with peak at 3.84% (3.37 to 4.34) in financial year 2016 to 2017, and the SSI risk staying stable in this financial year at 2.89% (2.48 to 3.34) compared to the previous financial year. This included infections at vein harvesting sites and the sternum. Cardiac surgery (non-CABG) shows fluctuating 10-year trend in annual SSI risk reaching a peak at 1.72% (1.32 to 2.19) in financial year 2016 to 2017, before decreasing to 1.42% (1.04 to 1.89) in the financial year 2021 to 2022 and 0.84% (0.56 to 1.22) in the current financial year. ([Figure 7f](#)).

For large bowel surgery ([Figure 7g](#)) the SSI risk remained similar to last year (8.15%; 7.09 to 9.32 and 8.04%; 6.96 to 9.22). The same was observed for small bowel surgery ([Figure 7h](#)) (7.79%; 5.52 to 10.62 and 7.33%; 5.21 to 9.95)

The SSI risk after spinal surgery ([Figure 7i](#)) has decreased steadily from its peak at 1.79% (1.51 to 2.11) in financial year 2015 to 2016 to 0.9% (0.67 to 1.18) in 2021 to 2022 before increasing marginally to 1.04% (0.79 to 1.33) in 2022 to 2023. The SSI risk following breast surgery ([Figure 7j](#)) has been decreasing between financial years 2017 to 2018 (1.12%; 0.81 to 1.51) and 2020 to 2021 (0.11%; 0.00 to 0.64)) and remained stable between this and previous financial year (0.63% and 0.65%, respectively).

Figure 7a. Trends in annual SSI risk for hip replacement, NHS hospitals England, April 2013 to March 2023

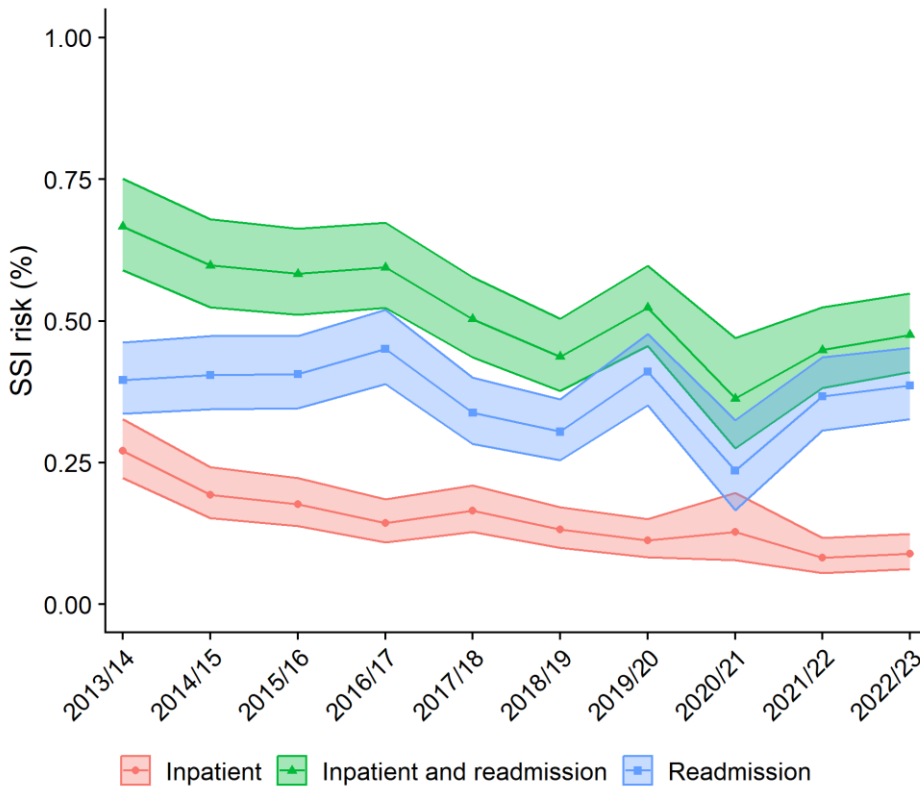


Figure 7b. Trends in annual SSI risk for knee replacement, NHS hospitals England, April 2013 to March 2023

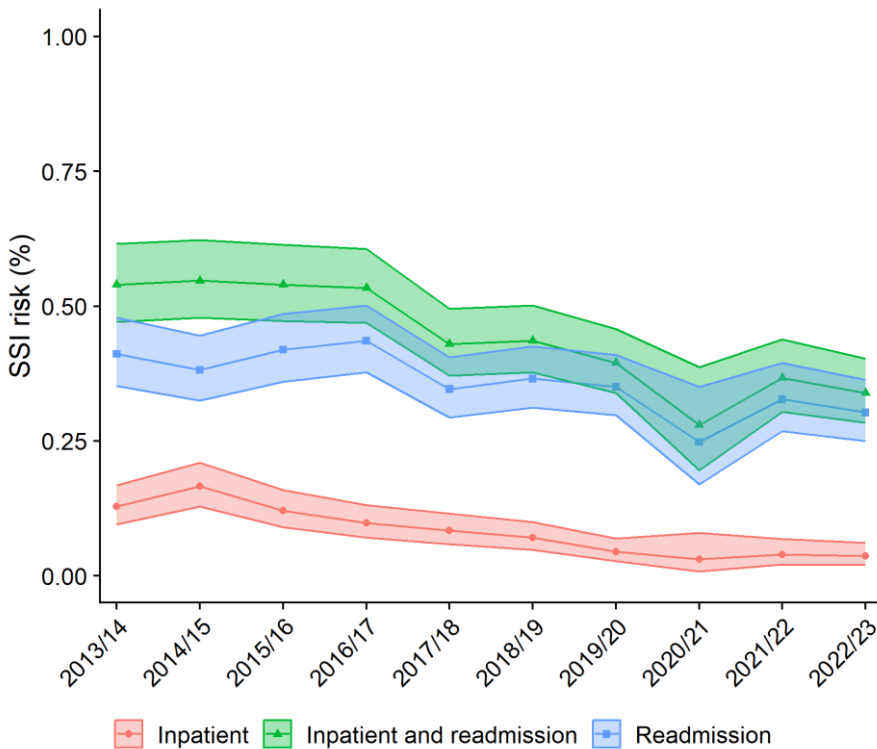


Figure 7c. Trends in annual SSI risk for reduction of long bone fracture, NHS hospitals England, April 2013 to March 2023

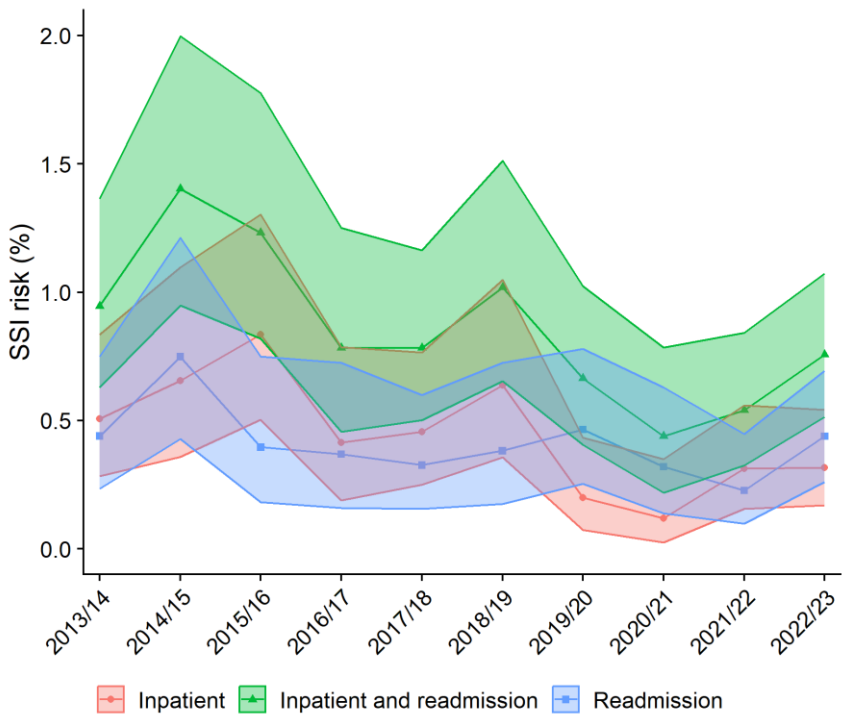


Figure 7d. Trends in annual SSI risk for repair of neck of femur, NHS hospitals England, April 2013 to March 2023

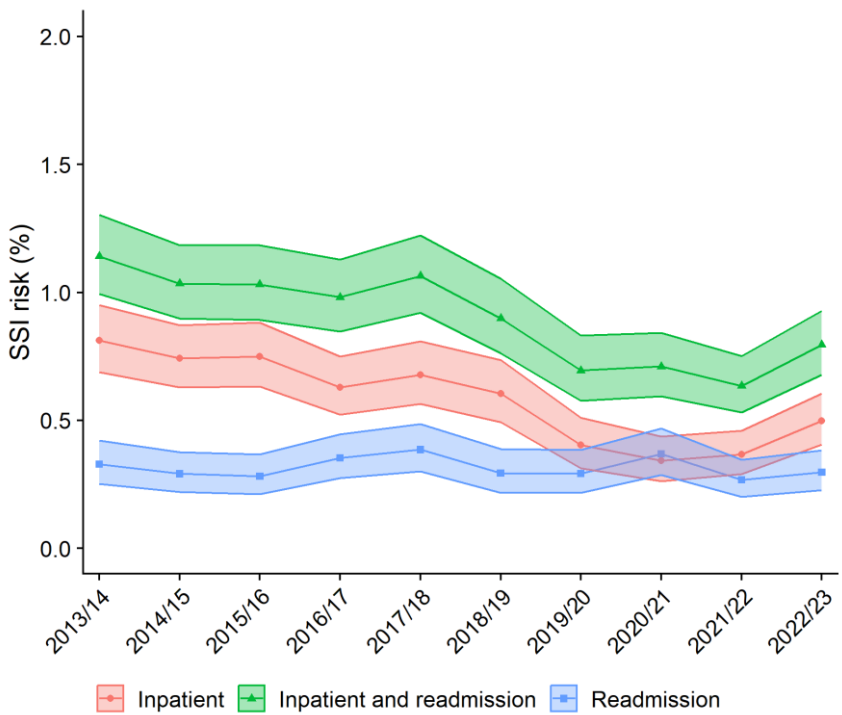


Figure 7e. Trends in annual SSI risk for coronary artery bypass graft (CABG) surgery, NHS hospitals England, April 2013 to March 2023

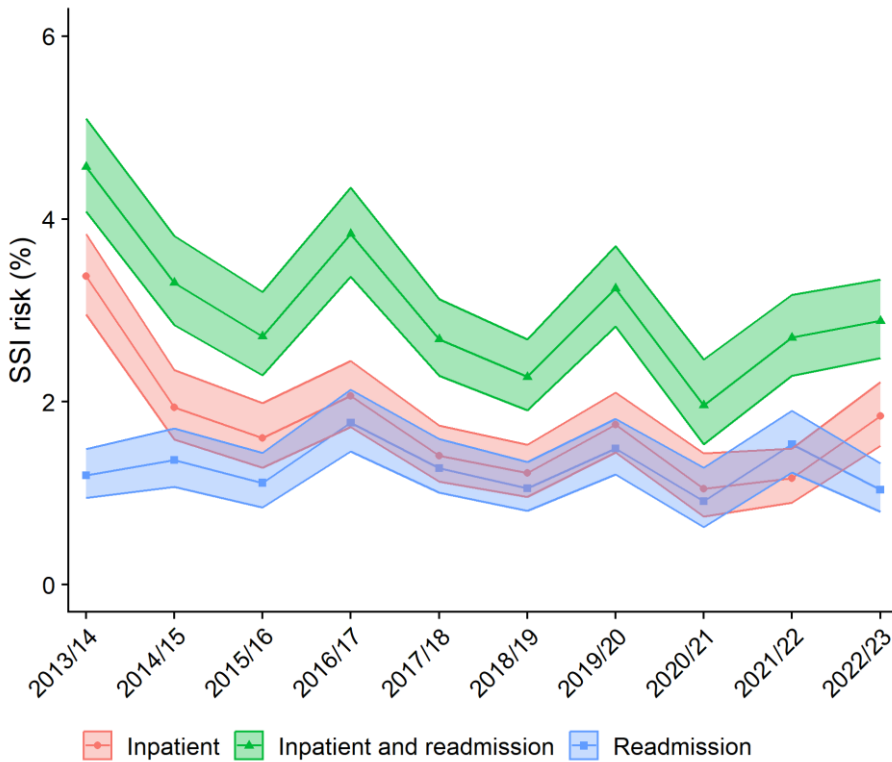


Figure 7f. Trends in annual SSI risk for cardiac (non-CABG) surgery, NHS hospitals England, April 2013 to March 2023

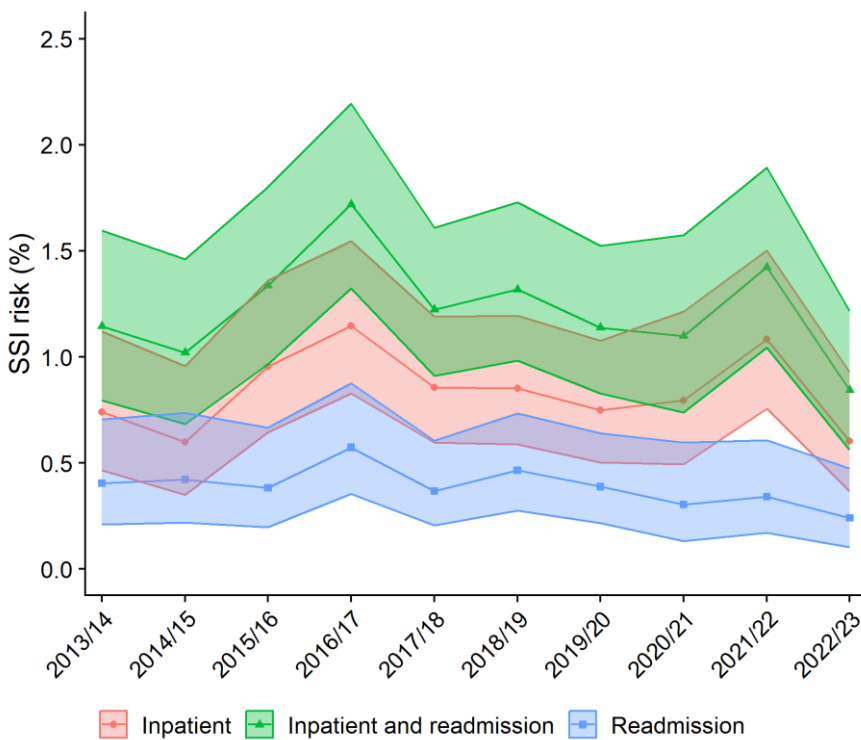


Figure 7g. Trends in annual SSI risk for large bowel surgery, NHS hospitals England, April 2013 to March 2023

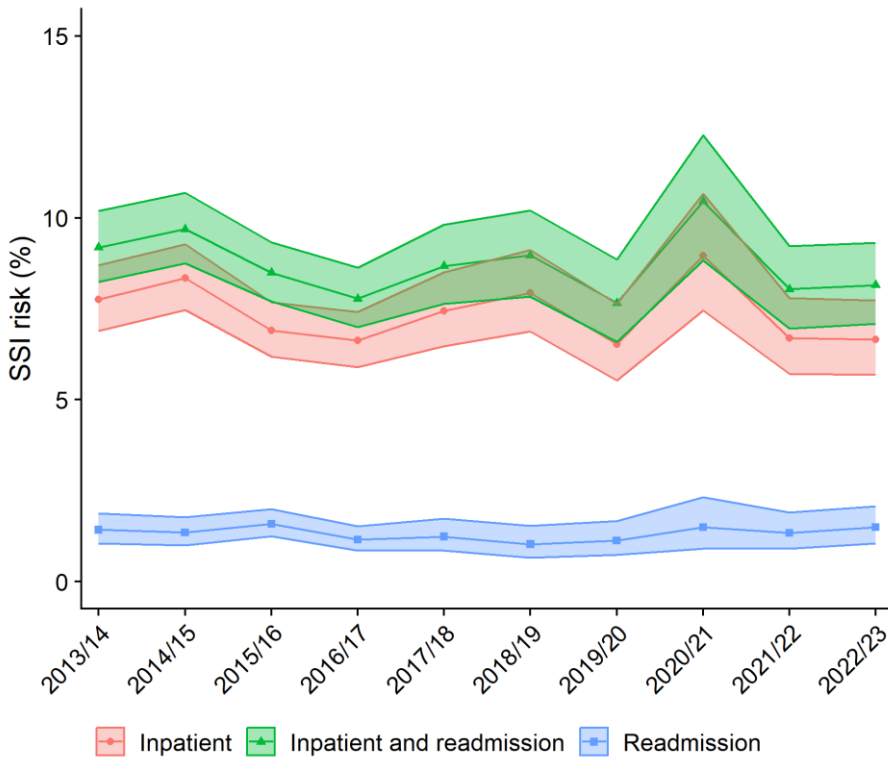


Figure 7h. Trends in annual SSI risk for small bowel surgery, NHS hospitals England, April 2013 to March 2023

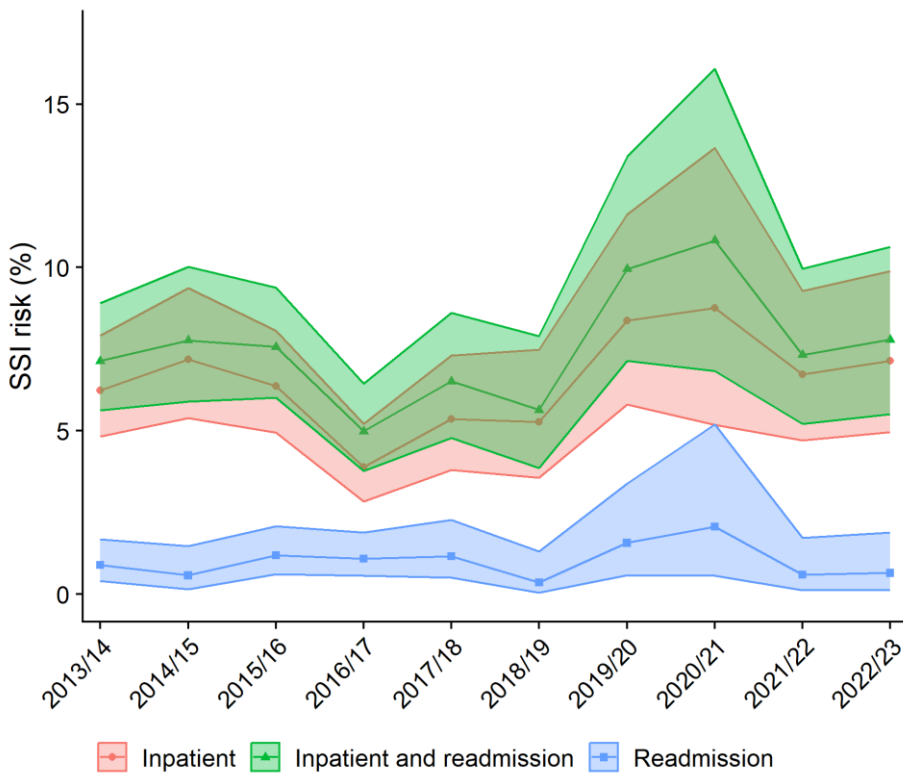


Figure 7i. Trends in annual SSI risk for spinal surgery, NHS hospitals England, April 2013 to March 2023

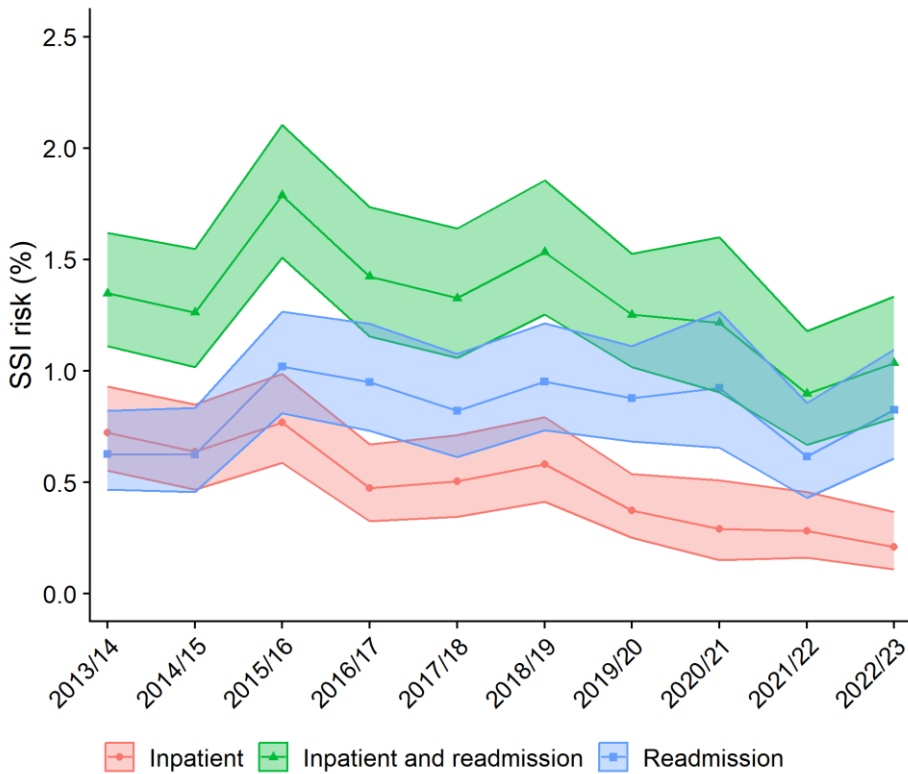
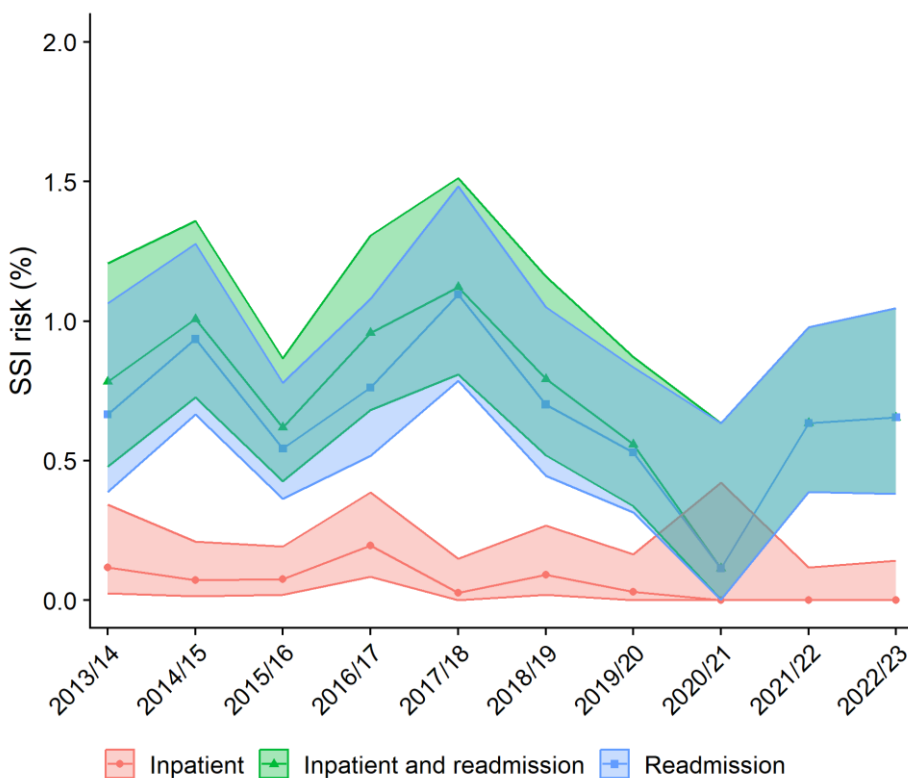


Figure 7j. Trends in annual SSI risk for breast surgery, NHS hospitals England, April 2013 to March 2023



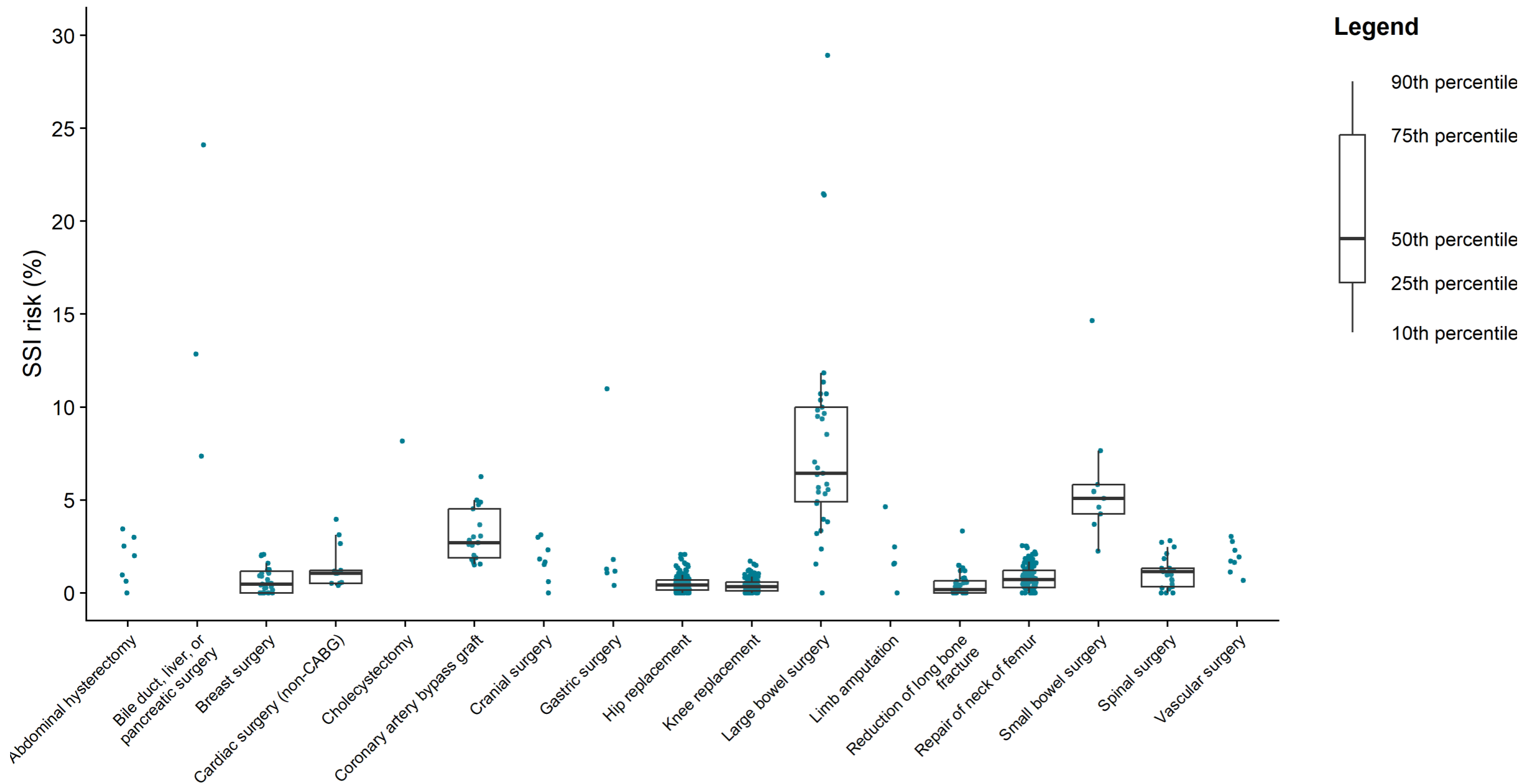
Variation in SSI risk between hospitals

[Figure 8](#) shows the distribution of the SSI risk, based on 5 years of cumulative data, across participating hospitals by surgical category using box-and-whisker plots. The box is formed of a lower quartile group (25th to 50th percentile) and an upper quartile group (50th to 75th percentile), defining an expected range of results. The 'whiskers', which are used to indicate variability outside the upper and lower quartile, use the 10th and 90th percentile to represent the extreme ends of the distribution and highlight hospital outliers, which fall outside this range. Each teal dot represents a participating hospital.

Similar to previous years, large bowel surgery showed the greatest variability with hospital SSI risk ranging from 1.1% to 28.9%, which could in part be due to variation in emergency surgeries but may also indicate room for improvement in infection prevention, and case ascertainment. Hip, knee replacement and reduction of long bone fracture showed the least variation, with most hospitals hovering around the median. However, high outlier hospitals can still be identified for these categories.

Of the 9 surgical categories with more than 10 participating hospitals, 3 had a narrower interquartile range (difference between the 25th and 75th percentiles) than the previous financial year, indicating less variation. All of the remaining 6 surgical categories had a wider interquartile range. When the current interquartile range was compared to the previous year, cardiac (non-CABG) surgery had the greatest percentage increase (105.1% increase) meaning there was more variation seen this year in the SSI risk across hospitals. This is in contrast to CABG surgery that had the greatest percentage decrease (23.1% decrease) in interquartile range between financial year 2021 to 2022 and 2022 to 2023.

Figure 8. Distribution of inpatient and readmission SSI risk by surgical category*, NHS hospitals England†, April 2018 to March 2023



* Categories with fewer than 10 hospitals participating within this time period are presented as a distribution without a box plot.

† NHS hospitals with less than 95 operations for hip replacement, knee replacement or abdominal hysterectomy are excluded from analysis for that category. NHS hospitals with less than 45 operations for any other category are excluded from analysis for that category.

Outlier assessment

In financial year 2022 to 2023, there were 2 NHS trusts performing orthopaedic surgery who did not comply with the mandatory requirements for participation in the SSISS and were notified by letter. For the mandatory orthopaedic categories, outliers are assessed at the end of each financial year across all NHS trusts and treatment centres using funnel plots to account for differences in surgical volume.

[Figures 9a-d](#) show funnel plots displaying variation in the SSI risk among trusts in financial year 2022 to 2023 for orthopaedic categories. The cumulative incidence of SSI per 100 procedures is plotted against the number of procedures for each participating NHS trust or treatment centre. The upper and lower 95% confidence limits (red lines) define the 'limits' of expected variation. Trusts lying outside these limits are outliers. The 99% confidence limits (dashed lines) are presented to represent the expected variation within which 99% of results should fall. The 95% confidence limits represent warning lines, whereas falling outside of the 99% confidence limits would signify the need for more immediate action.

Results showed similar variation across trusts and less consistent grouping around the national benchmark for hip and knee replacement surgery in financial year 2022 to 2023 compared to the previous financial year. Compared to financial year 2021 to 2022, there was also slightly more variation in SSI risk for reduction of long bone fracture and repair of neck of femur surgery.

Nine NHS acute trusts or treatment centres were identified as statistical high outliers (falling above the 95% upper confidence limits) across the 4 mandatory orthopaedic categories in financial year 2022 to 2023 (3 for hip replacement and repair of neck of femur, 2 for knee replacement and one for reduction of long bone fracture). Four NHS acute trusts or treatment centres were identified as statistical low outliers (falling below the 95% lower confidence limits) in financial year 2022 to 2023 (2 for hip replacement and repair of neck of femur, one for knee replacement). One of the 9 providers notified as high outliers was also a high outlier in the same category last financial year, and 3 of the 5 the providers deemed low outliers were also a low outlier in the same category in the previous financial year.

As part of this report, SSI risk results by NHS acute trust (and NHS treatment centres) for the last 2 financial years (2021 to 2022 and 2022 to 2023) are published in [separate accompanying tables](#).

[Annual trust-level results for hip and knee replacement surgery](#) are also made available through UKHSA's public reporting tool, Fingertips. The tool also allows users to group results by trust type (namely, teaching, non-teaching, and specialty) or NHS sub-region and compare to a corresponding overall group average.

Figure 9a. Distribution of inpatient and readmission SSI risk for hip replacement, NHS acute trusts and treatment centres England, April 2022 to March 2023

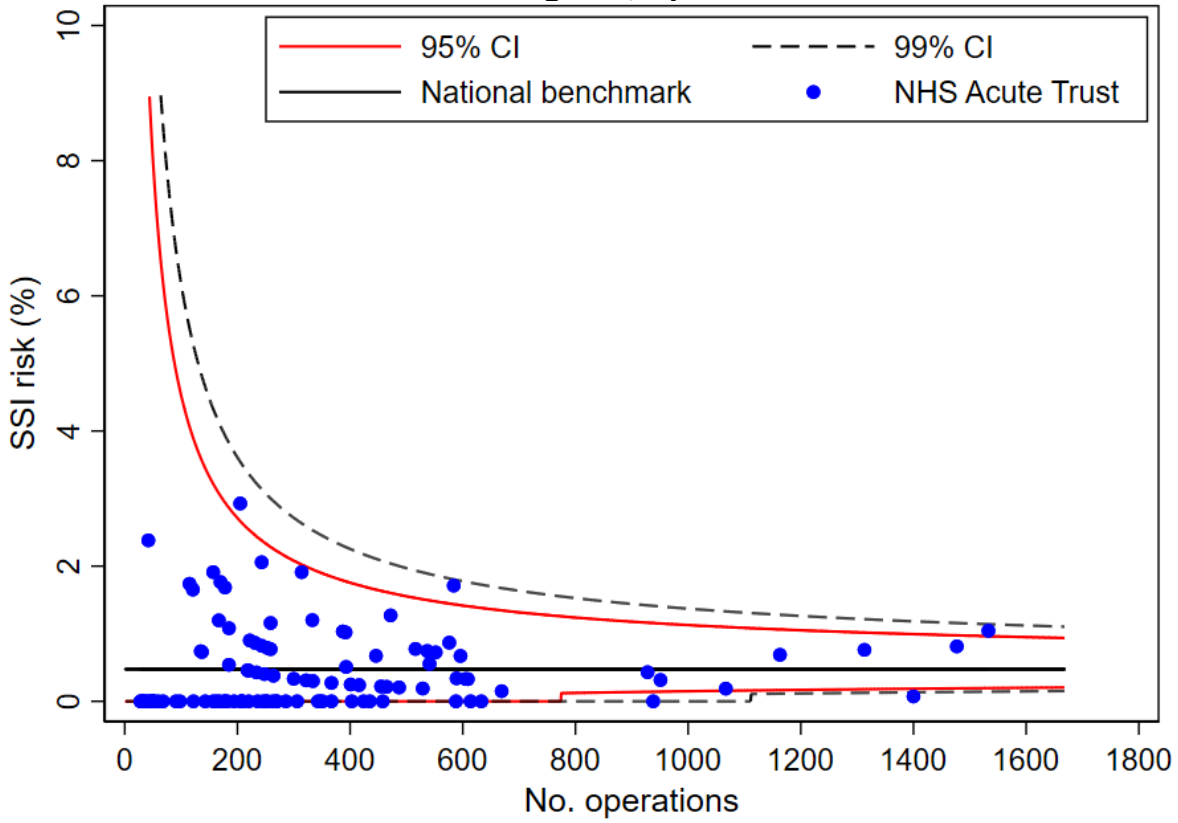


Figure 9b. Distribution of inpatient and readmission SSI risk for knee replacement, NHS acute trusts and treatment centres England, April 2022 to March 2023

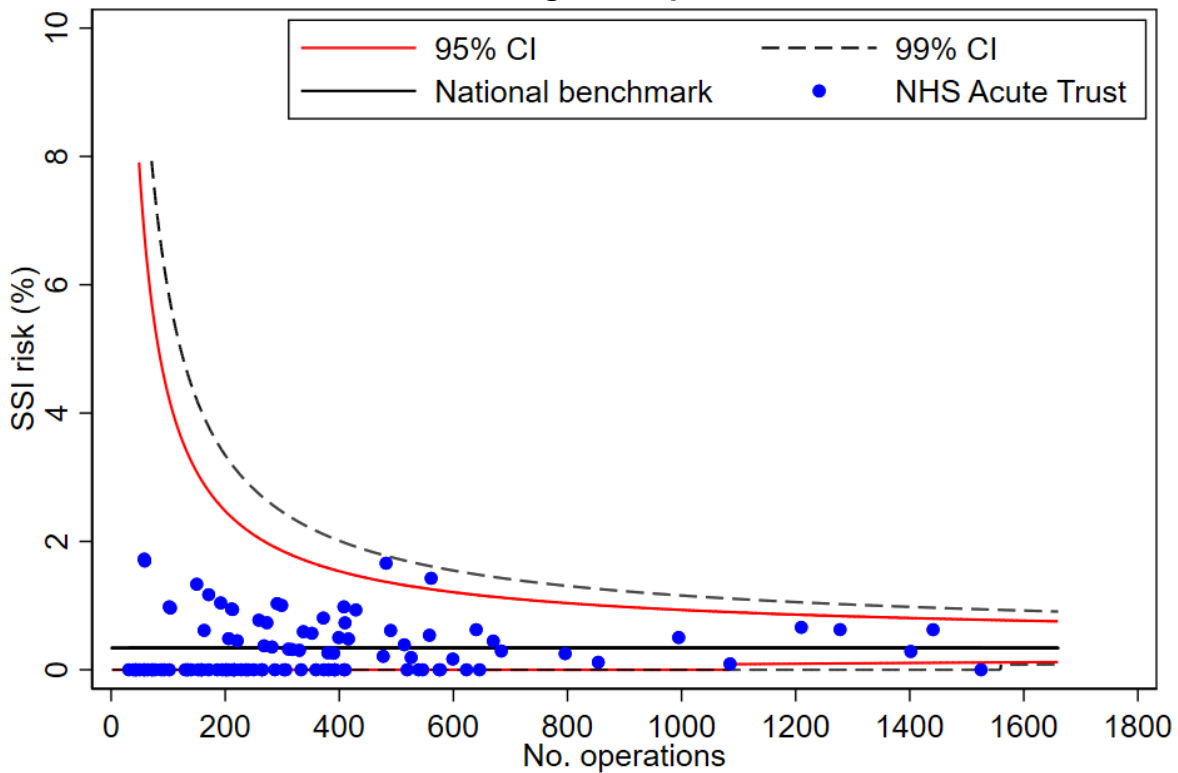


Figure 9c. Distribution of inpatient and readmission SSI risk for reduction of long bone fracture, NHS acute trusts and treatment centres England, April 2022 to March 2023

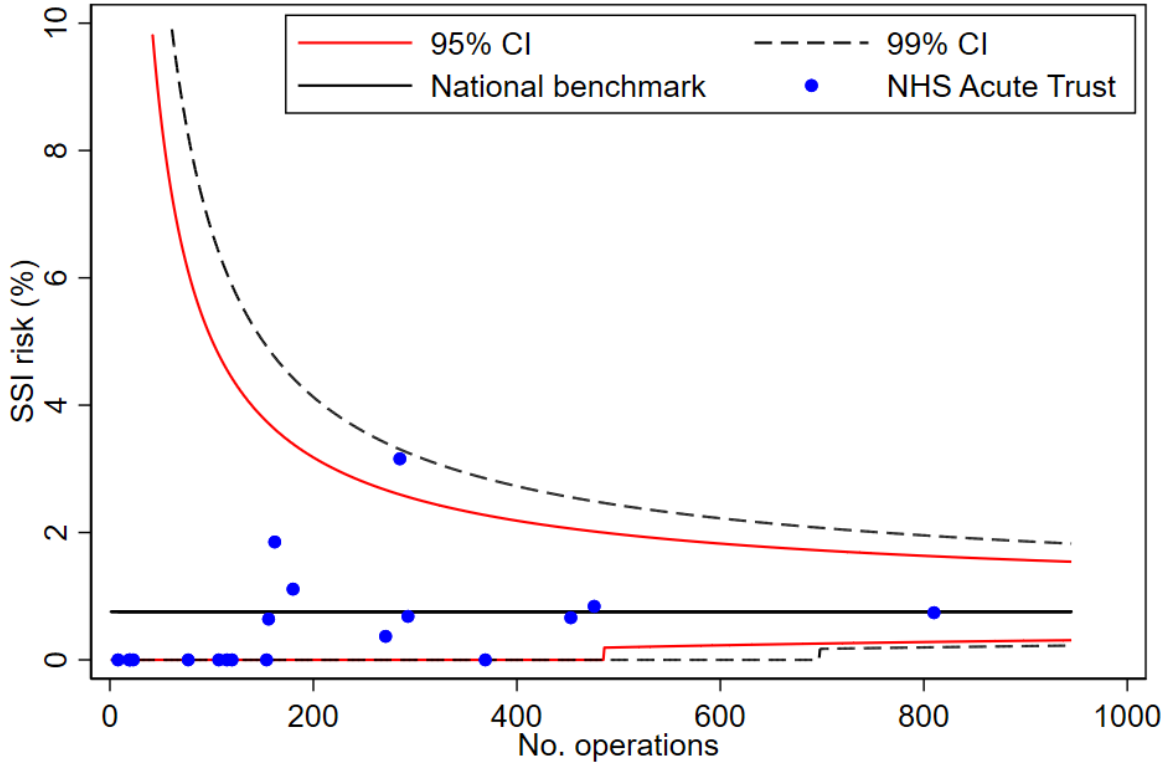
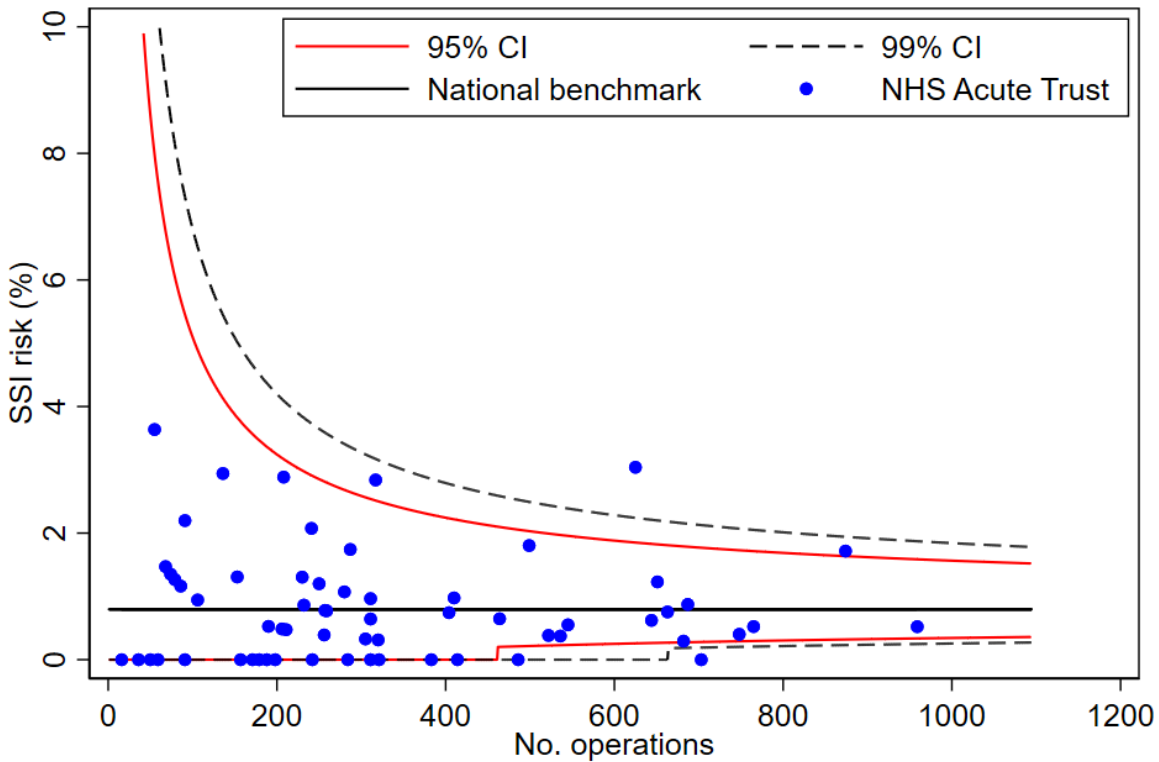


Figure 9d: Distribution of inpatient and readmission SSI risk for repair of neck of femur, NHS acute trusts and treatment centres England, April 2022 to March 2023



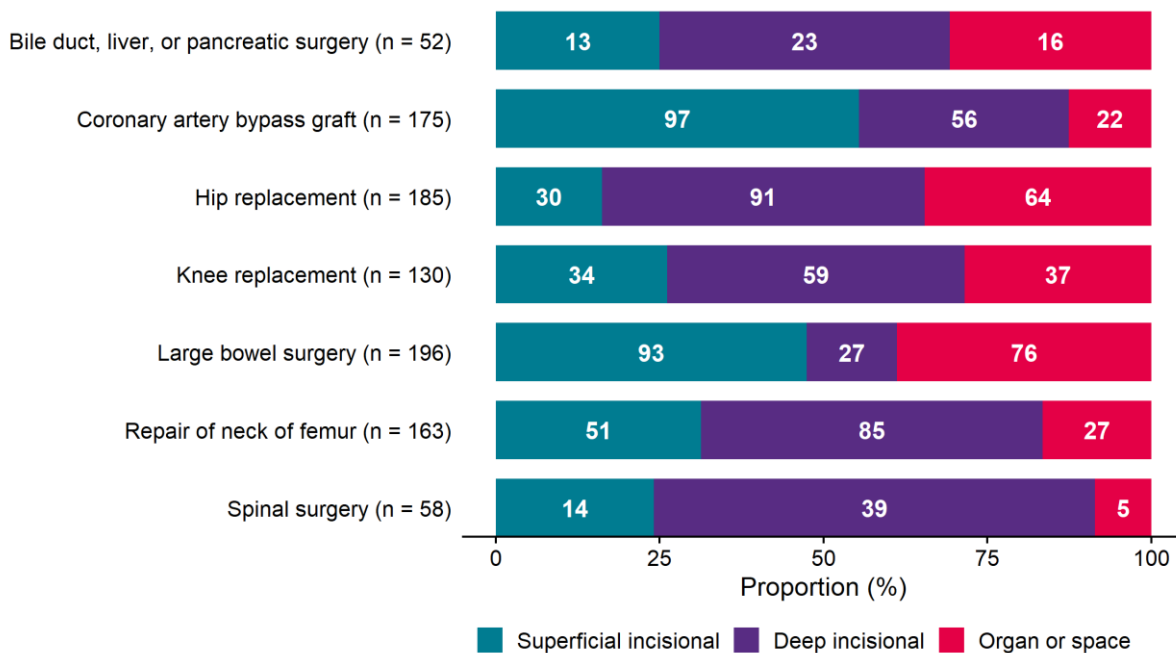
Characteristics of SSIs

Focus of SSI

Figure 10 shows the distribution of SSI types (superficial, deep or organ and space) by surgical category in financial year 2022 to 2023, where the number of inpatient and readmission SSIs per category was ≥ 45 . The distribution of type of infection varied by surgical category and may be attributed to differences in length of stay in hospital and follow-up care. Surgical categories with a shorter stay in hospital see relatively more readmission-detected SSIs, which increases the proportion of more serious wound complications. Patients undergoing procedures with a longer stay in hospital will undergo regular wound reviews so that infections may be more likely to get detected and treated earlier during the inpatient stay, and therefore may be more likely to be less severe.

In financial year 2022 to 2023, CABG and large bowel surgery continue to report the highest proportions of superficial incisional infections (55.4% and 47.5%, respectively) and both are long stay procedures. Compared to previous reports (financial year 2021 to 2022), the proportion of superficial SSIs following hip replacement surgery decreased (from 21.1% to 16.2%) as the proportion of organ or space SSIs increased (from 28.7% to 34.6%). Among the 7 categories, the highest proportion of organ or space SSIs was following large bowel surgery (38.8%). The proportion of organ or space SSIs following repair of neck of femur and spinal surgery decreased between previous and this financial year from 21.1% and 13.5% to 16.6% and 8.6%, respectively.

Figure 10. Proportion of SSI type for inpatient and readmission-detected SSIs by surgical category, NHS hospitals England, April 2022 to March 2023



Causative micro-organisms

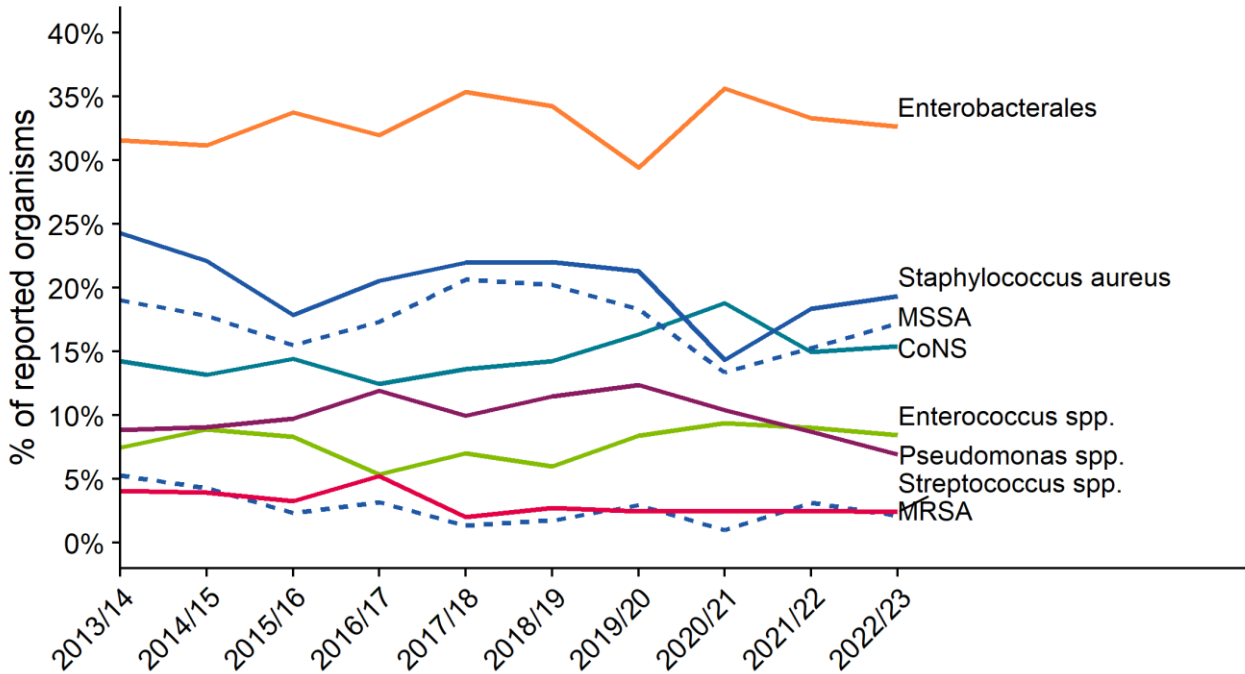
[Figure 11](#) shows 10-year trends in microbial aetiology of inpatient and readmission-detected superficial and deep or organ and space SSIs across all surgical categories. During this period there were 13,001 inpatient and readmission-detected SSIs reported, 71.1% (N=9,241) of which had accompanying microbiological confirmation. This proportion has increased from 63.4% in financial year 2013 to 2014 to 74.0% in 2022 to 2023. According to the UKHSA SSISS case definitions, positive microbiology is not essential to meet the SSI case definition provided there are other clinical indicators. Hospital surveillance staff have the option to provide up to 3 causative organisms per SSI. Hence, data presented here represents the proportion of infections in which an organism was detected and not the proportion of infections caused by a given organism.

Enterobacterales remain the most commonly reported organisms for all SSIs in financial year 2022 to 2023 but showed a decreasing 10-year trend for deep incisional SSIs. Enterobacterales were indicated in 32.6% of superficial SSIs and 26.8% of deep incisional or organ and space SSIs. The most common Enterobacterales species was *Escherichia coli*. The second most prevalent organism was *Staphylococcus aureus* (*S. aureus*) for both superficial SSIs (19.3%) and deep incisional or organ and space SSIs (20.6%). *S. aureus* increased in financial year 2022 to 2023 compared to the previous financial year for both superficial SSIs (from 18.4% to 19.3%) and deep incisional or organ and space SSIs (20.2% to 20.6%).

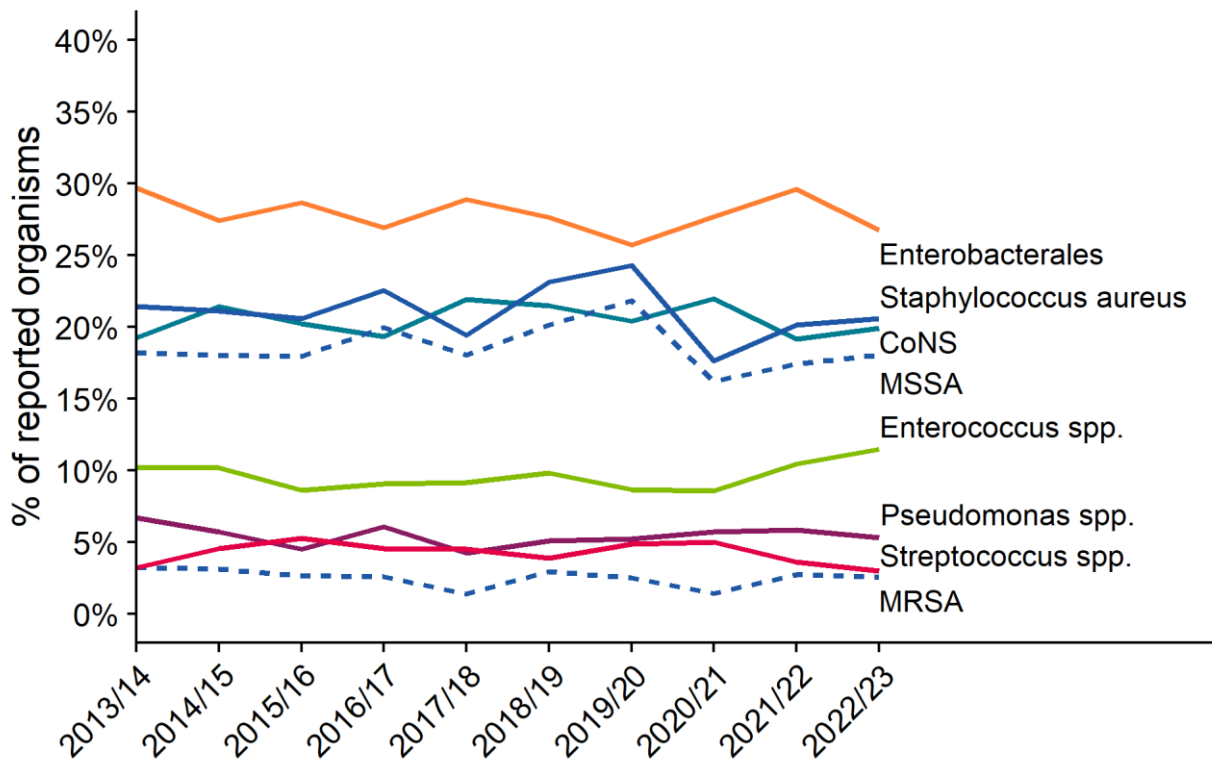
For both superficial and deep or organ and space infections, meticillin-sensitive *S. aureus* (MSSA) represents a much greater proportion of *S. aureus* infections than meticillin-resistant *S. aureus* (MRSA) (89.1% and 87.6% versus 10.9% and 12.4%, respectively). Among both types of infections, the proportion of MRSA reports decreased between the previous financial year and the current financial year (from 3.1% to 2.1% for superficial and from 2.7% to 2.5% for deep or organ and space). In contrast, the proportion of MSSA increased from 15.3% to 17.2% for superficial and from 17.4% to 18.0% for deep or organ and space infections between the latest 2 financial years. For MRSA, the proportion in 2022 to 2023 was lower than or similar to pre-pandemic for superficial SSIs (2.1% versus 3.0%) and deep or organ and space (2.5% versus 2.5%), while MSSA remained lower than pre-pandemic (superficial: 17.2% versus 18.3%; deep or organ and space: 18.0% versus 21.8%).

Figure 11. Micro-organisms reported in inpatient and readmission SSIs, all surgical categories, NHS hospitals England, April 2013 to March 2023

a) Superficial SSIs



b) Deep or organ and space SSIs



[Tables 5a-b](#) provide break down of the distribution of organisms reported in inpatient and readmission-detected SSIs by surgical category for superficial and deep or organ and space SSIs. Five years of data was used for these analyses (April 2018 to March 2023) to increase sample sizes.

Between April 2018 and March 2023, there were 2,460 monomicrobial (65.5%) and 1,298 polymicrobial (34.5%) inpatient and readmission SSIs.

Among monomicrobial SSIs (single organism reported as causing SSI), MSSA is the most commonly reported organism for hip replacement, knee replacement and spinal surgery among both superficial and deep or organ and space SSIs. Coagulase-negative Staphylococci (CoNS) make up almost a quarter of monomicrobial organisms associated with deep or organ and space SSIs for 4 of the 6 categories assessed including knee replacement (23.5%), repair of neck of femur (28.4%), hip replacement (21.1%) and CABG (26.9%). Compared to deep or organ and space SSIs, superficial SSIs reported a smaller proportion of CoNS causative microorganisms, except for spinal (25.4%) and CABG surgery (31.8%).

Enterobacterales were most prevalent in large bowel surgery SSIs, contributing 53.8% of superficial SSIs and 57.9% of deep or organ and space SSIs. Compared to the previous financial year, the proportion of SSIs with Enterobacterales isolates following hip replacement decreased (superficial: 12.5% versus 18.3%; deep or organ and space: 20.1% versus 20.3%). Repair of neck of femur and CABG surgery showed the greatest decrease in proportion of deep or organ and space SSIs due to Enterobacterales between 2021 to 2022 and 2022 to 2023 (from 31.0% to 24.7% and from 23.2% to 19.4%, respectively).

Polymicrobial SSIs (cases with more than one organism reported as causing SSI) were most common in large bowel surgery. The proportions were greater in deep or organ and space SSIs (60.4%) compared to superficial SSIs (35.8%). Around a third to a half of deep or organ and space polymicrobial infections involved a combination of Gram-positive and Gram-negative organisms across all surgical categories (from 29.0% for spinal surgery to 55.2% for large bowel surgery). Among superficial SSIs, the proportions of combined Gram-positive and Gram-negative polymicrobials were slightly higher (from 39.1% for hip replacement to 57.1% for knee replacement).

The proportion of polymicrobial SSIs with combinations of Gram-negative bacteria was highest for large bowel for superficial SSIs (22.7%) and CABG surgery for deep of organ and space SSIs (19.2%). Categories other than large bowel and CABG had a higher proportion of Gram-positive only combinations (from 14.3% for knee replacement to 43.5% for hip replacement) for superficial SSIs. For deep or organ and space SSIs, the proportion of Gram-negative polymicrobial infections was lower than superficial SSIs across all surgical categories, except hip replacement (7.4% versus 4.3%).

The proportion of deep or organ and space SSIs caused by Gram-positive combinations was significantly higher than that for superficial SSIs for knee replacement (41.3% for deep and

organ and space SSIs versus 14.3% for superficial SSIs) and spinal surgery (53.6% for deep and organ and space SSIs versus 36.8% for superficial SSIs). While the difference between the proportion of superficial and deep or organ and space SSIs caused by Gram-negative combinations for hip replacement was two-fold in the previous financial year, this wasn't observed this financial year (43.5% for superficial SSIs versus 46.6% for deep or organ and space SSIs).

Table 5a. Micro-organisms reported as causing inpatient and readmission detected SSIs (superficial SSIs), all surgical categories*, NHS hospitals, England, April 2018 to March 2023

	Reported causative organism	Hip replacement		Knee replacement		Repair of neck of femur		Large bowel		Spinal surgery		Coronary artery bypass graft	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Monomicrobial	Meticillin-sensitive <i>S. aureus</i>	37	46.3	35	53.8	37	36.6	8	4.1	28	47.5	34	17.7
	Meticillin-resistant <i>S. aureus</i>	9	11.3	3	4.6	6	5.9	1	0.5	1	1.7	4	2.1
	Coagulase-negative staphylococci	11	13.8	10	15.4	18	17.8	10	5.1	15	25.4	61	31.8
	Enterobacterales	10	12.5	6	9.2	23	22.8	106	53.8	12	20.3	48	25.0
	<i>Pseudomonas</i>	4	5.0	1	1.5	5	5.0	28	14.2	3	5.1	28	14.6
	<i>Streptococcus</i>	3	3.8	1	1.5	0	0.0	5	2.5	0	0.0	0	0.0
	<i>Enterococcus</i>	3	3.8	2	3.1	5	5.0	18	9.1	0	0.0	3	1.6
	Other bacteria	3	3.8	6	9.2	4	4.0	4	2.0	0	0.0	8	4.2
	Fungi including <i>Candida</i> spp.		0.0		0.0	1	1.0	4	2.0		0.0	2	1.0
	<i>Acinetobacter</i> spp.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5
	Anaerobic bacilli	0	0.0	1	1.5	1	1.0	1	1.0	7	3.6	2	1.0
	Anaerobic cocci	0	0.0	0	0.0	1	1.0	6	3.0	0	0.0	1	0.5
	Total monomicrobial		80	100	65	100	101	100	197	100	59	100	192
Polymicrobial	Gram-positive combinations only	10	43.5	3	14.3	9	36.0	4	3.6	7	36.8	12	14.0
	Gram-negative combinations only	1	4.3	2	9.5	4	16.0	25	22.7	3	15.8	18	20.9
	Gram positive and gram-negative combinations	9	39.1	12	57.1	10	40.0	61	55.5	9	47.4	48	55.8
	Other	3	13.0	4	19.0	2	8.0	20	18.2	0	0.0	8	9.3
Total polymicrobial		23	100	21	100	25	100	110	100	19	100	86	100
Total cases**		103	100	86	100	126	100	307	100	78	100	278	100

* Total cases are specific to this analysis and refers to those with available microbiology information

** Total cases for combined monomicrobial and polymicrobial specimen

Table 5b. Micro-organisms reported as causing inpatient and readmission detected SSIs (deep and organ space SSIs), all surgical categories*, NHS hospitals, England, April 2018 to March 2023

	Reported causative organism	Hip replacement		Knee replacement		Repair of neck of femur		Large bowel		Spinal surgery		Coronary artery bypass graft	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Monomicrobial	Meticillin-sensitive <i>S. aureus</i>	142	38.0	126	43.4	51	18.8	4	4.2	81	48.5	45	28.1
	Meticillin-resistant <i>S. aureus</i>	18	4.8	12	4.1	22	8.1	0	0.0	2	1.2	6	3.8
	Coagulase-negative staphylococci	79	21.1	68	23.4	77	28.4	4	4.2	31	18.6	43	26.9
	Enterobacterales	75	20.1	25	8.6	67	24.7	55	57.9	30	18.0	31	19.4
	<i>Pseudomonas</i>	10	2.7	10	3.4	13	4.8	5	5.3	5	3.0	11	6.9
	<i>Streptococcus</i>	27	7.2	29	10.0	5	1.8	4	4.2	0	0.0	1	0.6
	<i>Enterococcus</i>	11	2.9	5	1.7	21	7.7	13	13.7	4	2.4	7	4.4
	Other bacteria	6	1.6	10	3.4	9	3.3	1	1.1	7	4.2	9	5.6
	Fungi including <i>Candida</i> spp.	2	0.5	1	0.3	0	0.0	3	3.2	0	0.0	5	3.1
	<i>Acinetobacter</i> spp.	0	0.0	0	0.0	0	0.0	1	1.1	0	0.0	1	0.6
	Anaerobic bacilli	4	1.1	3	1.0	5	1.8	2	2.1	5	3.0	1	0.6
	Anaerobic cocci	0	0.0	1	0.3	1	0.4	3	3.2	2	1.2	0	0.0
	Total monomicrobial	374	100	290	100	271	100	95	100	167	100	160	100
Polymicrobial	Gram-positive combinations only	88	46.6	58	41.4	58	34.3	7	4.8	37	53.6	16	17.0
	Gram-negative combinations only	14	7.4	13	9.3	22	13.0	19	13.1	9	13.0	18	19.1
	Gram positive and gram-negative combinations	83	43.9	57	40.7	78	46.2	80	55.2	20	29.0	46	48.9
	Other	4	2.1	12	8.6	11	6.5	39	26.9	3	4.3	14	14.9
	Total polymicrobial	189	100	140	100	169	100	145	100	69	100	94	100
	Total cases**	563	100	430	100	440	100	240	100	236	100	254	100

* Total cases are specific to this analysis and refers to those with available microbiology information

** Total cases for combined monomicrobial and polymicrobial specimen

Patient post discharge questionnaire (PDQ)

Whilst SSIs detected through optional post discharge surveillance are not included in this annual report, we describe trends in uptake of the existing PDQ (16). [Figure 12](#) shows PDQs given as a percentage of the number of operations, and the proportion of PDQs completed as a percentage of the number of PDQs given (2013 to 2023). The proportion of patients under surveillance given a PDQ indicates the coverage of total operations by PDQ surveillance. This proportion increased from 44.7% in financial year 2013 to 2014 to 53.1% in 2022 to 2023, with similar proportion during the height of the COVID-19 pandemic despite the reduction seen in the number of operations.

The proportion of PDQs completed of those given increased from 71.8% in 2013 to 2014 to 79.3% in 2022 to 2023, showing that where PDQs are given there is a high response rate. Given that not all hospitals are utilising PDQs, the overall proportion of operations with a completed PDQ was less than half over the past 10 years although showing a steady increase from 32.1% to 42.1% (between 2013 to 2014 and 2022 to 2023).

Figure 12: Uptake and completion of PDQs as a proportion of all operations and where PDQ given, by financial year, NHS hospitals England, April 2013 to March 2023

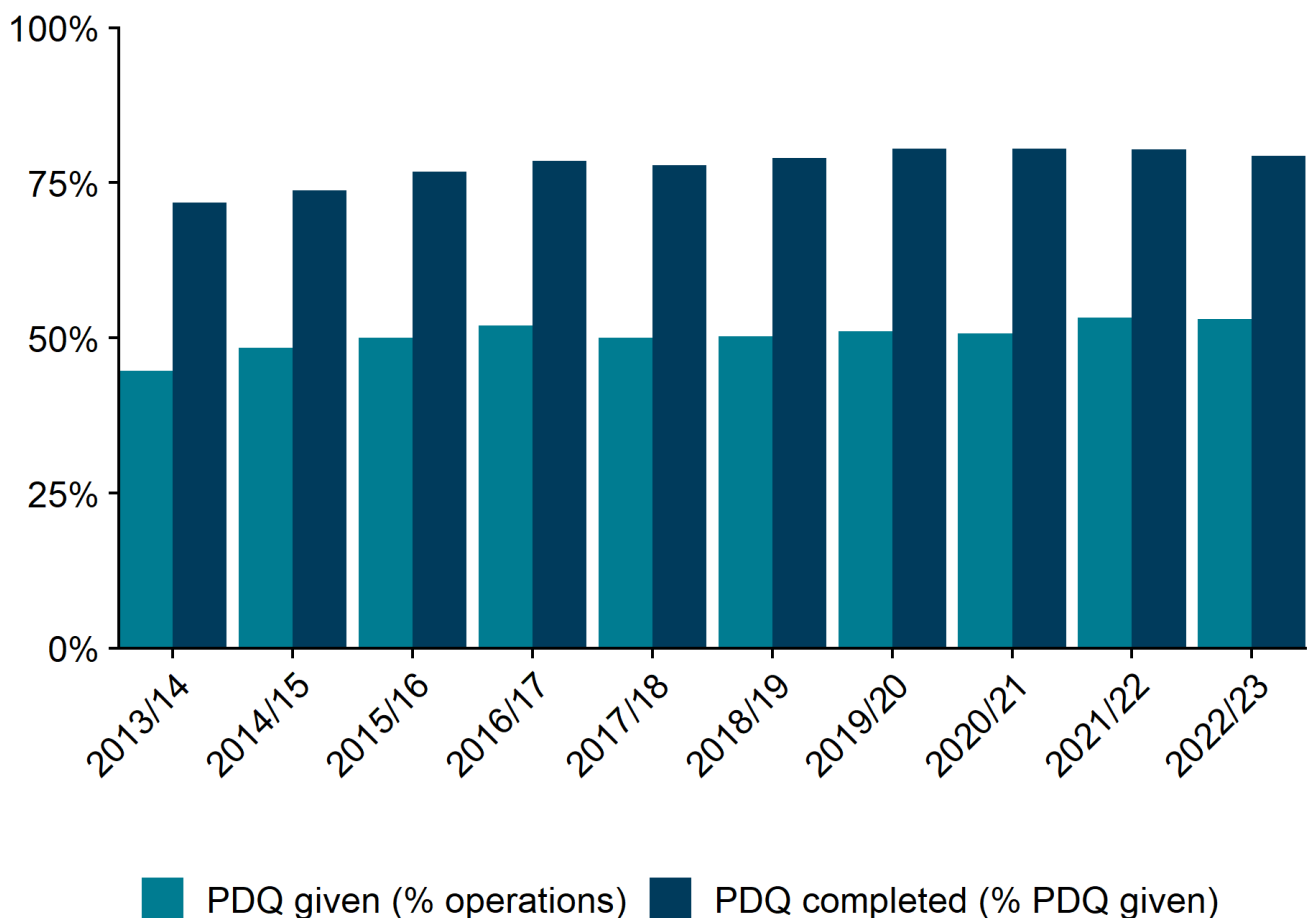
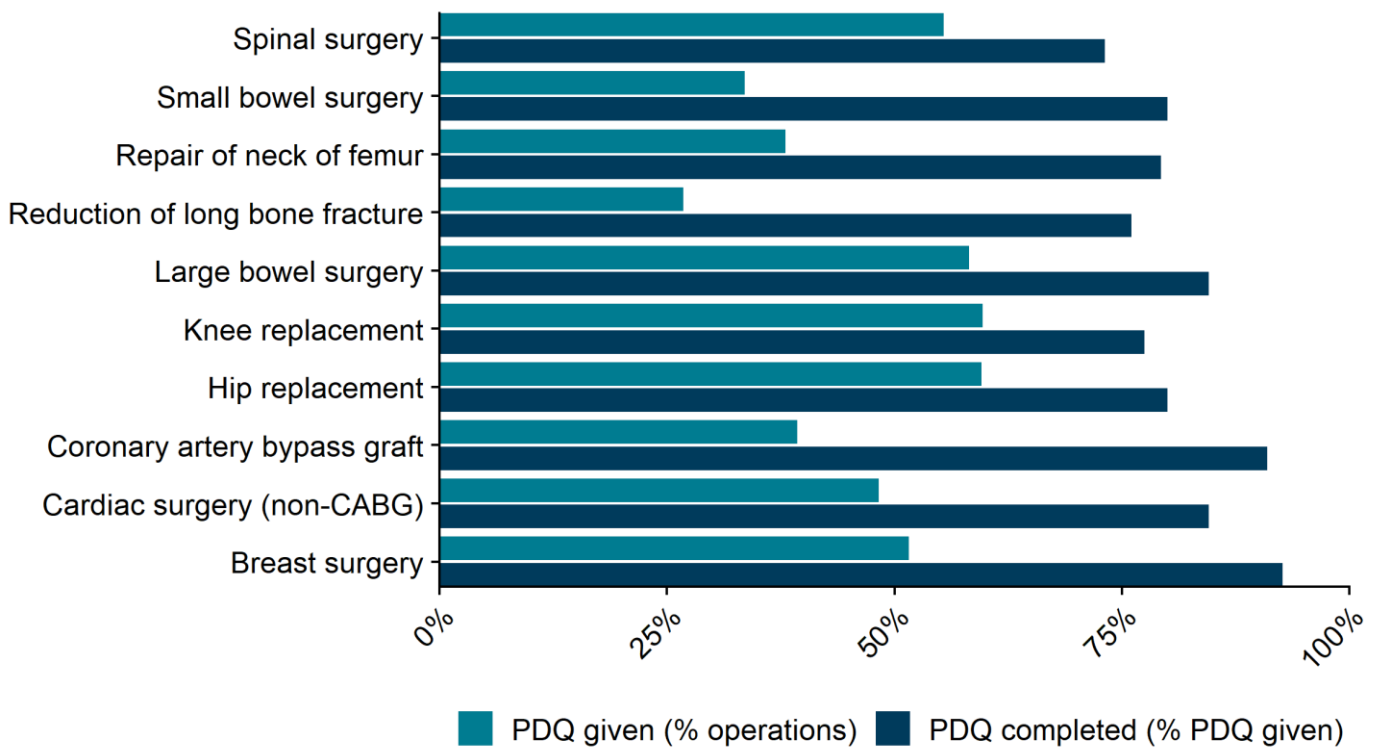


Figure 13 shows the proportion of PDQs given (as a percentage of operations) and PDQs completed (as a percentage of PDQs given) among categories with more than 5 participating hospitals in financial year 2022 to 2023. The proportion of operations with a PDQ given ranged from 26.8% for reduction of long bone fracture to 59.7% for knee replacement. Categories with shorter lengths of stay (median 0 to 3 days) including hip and knee replacement, spinal surgery, and breast surgery had higher uptake of PDQs. The proportion of operations given PDQ increased for large bowel surgery from 33.6% in 2021 to 2022 to 58.2% in 2022 to 2023. The proportion of PDQs completed (of PDQ given) was above 70% for all categories, the highest being for breast surgery (92.6%).

Figure 13. Uptake of PDQs as a proportion of all operations and completion of PDQs where PDQ given, by category, NHS hospitals England, April 2022 to March 2023



Discussion

Through partnership working with NHS and independent sector healthcare providers, the UKHSA SSISS has amassed a wealth of information, having accumulated surveillance data for almost 3 million operations and 58,000 SSIs since its inception in 1997. In financial year 2022 to 2023, submissions of data for both mandatory and voluntary surgical categories increased compared to the previous financial year. This trend was likely due to an increase in routine surgeries after the reductions due to COVID-19 in financial year 2020 to 2021 and 2021 to 2022. Despite the 8.4% increase in the number of procedures reported to the surveillance, the number of procedures reported remained 7.0% lower than pre-pandemic (financial year 2019 to 2020). This may reflect the changing volumes of elective orthopaedic procedures carried out by the private sector. According to the 2023 Joint Registry Annual Report, the volume of joint replacements carried out in the private sector has increased hugely since the pandemic with more hip replacements performed in the independent sector than the NHS currently (17). This is however not presented in this report which only includes NHS hospitals and independent sector treatment centres that are contracted to carry out work on behalf of NHS, despite some independent sector hospitals submitting data to the SSISS.

In financial year 2022 to 2023, 10-year trends in the annual inpatient and readmission SSI risk showed that 9 of 10 surgical categories assessed showed a declining trend, including all of the mandatory orthopaedic categories. In the most recent 2 financial years, hip replacement, CABG surgery, reduction of long bone fracture and breast surgery has shown the same trend (increasing SSI risk in both years). The fluctuation in trend for most categories assessed may be due to changes in infection prevention control measures during COVID-19, changes to adherence of SSISS protocols, or changes in number of operations submitted meaning more variation in the calculated SSI risks.

Cardiac surgery (non-CABG) decreased from 1.42% in financial year 2021 to 2022 to 0.84% in financial year 2022 to 2023, which is the lowest SSI risk in 10 years. The SSI risk for large bowel increased to 8.15% from previously reported 10-year low. The considerable inter-hospital variation in SSI risk following large bowel surgery, with 5-year hospital rates ranging from 0.0% to 28.9% persisted. This indicates that there may be room for improvement through review of infection prevention control, sharing of best practice from mentor hospitals, bowel preparation prior to surgery in conjunction with oral antibiotics and case ascertainment practices (18). However, there may be differences in the distribution of patient risk factors between hospitals, or other risk factors such as emergency surgery, which was recorded in 5.3% of large bowel procedures in 2022 to 2023.

Annual trust-level SSI risk funnel plots in financial year 2022 to 2023 showed more variation in the SSI risk across trusts and less consistent grouping around the national benchmark for the mandatory orthopaedic surveillance categories. This trend of more variation is similar to the previous financial year and in contrast to the trend seen in the 2 financial years prior to that. Nine high outlier notifications were sent out for the mandatory surveillance categories

compared to 4 in the previous year. High outliers emphasize the importance of continued surveillance and monitoring as differences in the population at risk and risk factors at the time of surgery may result in periodic increases in infections regardless of a hospital's own prior history and the declining national benchmark.

There were 5 low outlier notifications and 3 of the trusts were a low outlier in the same category the previous year. This may be indicative of low case ascertainment or exceptional patient care. Annual trust outlier assessments are unadjusted for differences in the patient population and important risk factors. Hospitals who receive outlier notifications are encouraged to investigate possible reasons for higher than expected risks of infection. This would include examination of surveillance data at a more granular level through web-based hospital reports which include risk-stratified data, reviewing IPC policies and surgical practice, such as the use of prophylactic antimicrobials and contacting the SSIS team for further support.

For operations with recorded height and weight, more than half of the patients undergoing a knee replacement procedure were obese (57.0% in financial year 2022 to 2023). An elevated BMI has been shown to increase the likelihood of developing an SSI (14, 15). However, a 2017 report found that 47% of Clinical Commissioning Groups (CCGs) in the UK have a BMI threshold in place for funding surgery (19). At that time, the majority of these CCGs applied a threshold of 35 kg/m² or more, however 10% set a threshold of 30 kg/m² ('obese') and 4% set a threshold of 25 kg/m² ('overweight'). In financial year 2022 to 2023, the median patient BMI decreased slightly for more than half of the surgical categories, which may suggest selective access to elective surgery based on a lower patient BMI, especially for non-urgent surgeries. Completion of BMI has not changed between financial years 2021 to 2022 and 2022 to 2023 (59%). BMI information will be important to consider when assessing high hospital outliers, especially where BMI thresholds continue to be applied by Integrated Care Boards (replaced CCGs, established July 2022).

A previous study showed difference in unadjusted risk of SSI according to patient ethnicity, but with this difference diminished after adjusting for IMD and patient and surgery related risk factors (20). Based on 5-year data between April 2018 and March 2023, there was some indication of an increased risk of SSI for non-white ethnic groups compared to white patients, however confidence intervals overlapped in all of these meaning statistical significance for these differences was not reached.

In assessing analyses of SSI risk distribution by selected social determinants of health, it is important to recognise that these do also serve as proxies of wider, more complex social dynamics that influence health outcomes in the society. There is a compelling body of evidence that health patterns and access to health vary between social groups, and highlighting some of these differences can be helpful in addressing wider health inequalities. However, discerning the causes of health inequalities is complex, as many of the factors are interlinked, and therefore out of the scope of this report (21).

Similarly, as for the difference in SSI risk by ethnicity, the risk varied by IMD decile for surgical categories. There was an indication of higher SSI risk in LSOAs in deciles with higher deprivation for several orthopaedic and non-orthopaedic surgical categories. However, accompanying confidence intervals were wide and overlapped.

The UK 5-year (2019 to 2024) national action plan for antimicrobial resistance sets out to reduce healthcare-associated Gram-negative bloodstream infections (BSI) by 50% (22). Given this concern it is important that we continue to monitor the proportion of SSI caused by Gram-negative bacteria such as Enterobacterales. In financial year 2022 to 2023, superficial SSIs but not deep or organ and space SSIs showed an increasing 10-year trend in the proportion of Enterobacterales SSIs, which highlights the need for ongoing surveillance.

In financial year 2022 to 2023, the proportion of SSIs from which MRSA was isolated decreased for both superficial and deep or organ and space infections in contrast to the proportion of SSIs caused by MSSA which increased. The proportions of MRSA decreased to pre-pandemic levels, while those for MSSA remained below pre-pandemic levels notwithstanding the recent increase.

Despite this increase in the proportion of SSIs involving MSSA, there is a decreasing 10-year trend for superficial SSIs involving *S. aureus* and a stable trend for deep or organ and space SSIs. Capture of microbial aetiology continues to play a key role in prevention of SSI through optimising choice of antibiotic prophylaxis in surgery and may result in downstream reduction of bacteraemia caused by SSI.

The proportion of PDQs given and the proportion of PDQs completed (as a percentage of the number of all operations) both showed an increasing trend, reaching 53.1% and 42.1% respectively in financial year 2022 to 2023. The proportion of PDQs completed from the number of PDQs given has remained high for the last 10 years and reached 79.3% in 2022 to 2023, showing that where PDQs are given there is a high response rate. At the category level, the response rate for PDQs completed (from PDQs given) was also high for all categories with more than 5 participating hospitals, with breast surgery showing that 92.6% of all PDQs given were completed.

As the provision and completion of PDQs is not mandatory, albeit strongly recommended by the SSISS team for procedures with short length post-operative stay, SSIs detected through PDQs are not currently included in our analysis. The PDQ is currently paper-based or administered by phone and therefore comes with an administrative overhead. Despite this, over 50% of operations were administered a PDQ illustrating the value hospitals and SSISS place in obtaining more comprehensive estimate of the SSI burden, particularly for categories with short length of stay. The PDQ would be particularly useful to the patients undergoing their procedures in the private sector given the higher likelihood them being readmitted to other hospitals due to post-operative complications.

An electronic PDQ (ePDQ) is in beta phase development and this should help increase hospital uptake of PDQ surveillance by easing the administrative burden and increase response rates by patients. This will provide hospitals with a more sensitive SSI measure when looking at trends in their data over time.

While this report shows that some trends are returning to pre-pandemic levels (2019 to 2020), the impact of COVID-19 on healthcare delivery in terms of backlog of elective surgery is ongoing. We will continue to monitor and assess the contribution of COVID-19 on SSI trends.

Glossary

ASA score

Patient's pre-operative physical status scored by the anaesthetist according to the American Society of Anesthesiologists' classification of physical status. There are 5 ASA scores, ranging from A1 denoting normally healthy patient to A5 denoting moribund patient with little chance of survival.

Confidence intervals

Confidence intervals are used to show where the true range of results might lie. Ninety-five percent confidence intervals are used throughout to provide a guide to the precision of the estimate based on the denominator, number of operations (or days of follow-up), with narrower intervals representing greater confidence in the estimate and broader confidence intervals representing lower certainty in the estimate. Given the same sampling, the estimate will fall within the confidence intervals 19 times out of 20. The funnel plots use both 95% and 99% confidence limits to represent the limits of expected variation among trusts and establish a threshold for 'warning' of an unexpected result and needing to take 'action'. A 99% confidence range is wider but is offset with a lower margin of error (1%).

Cumulative incidence

The total number of SSIs as a proportion of the total number of patients undergoing a procedure in the same category of surgery per 100 procedures (%).

Incidence density

The total number of SSIs (identified through inpatient surveillance) divided by the total number of days of inpatient follow-up expressed as the number of SSIs per 1,000 days of patient follow-up.

Independent sector NHS treatment centres

Centres that provide services to NHS patients but are owned and run by organisations outside the NHS. They perform common elective (non-emergency) surgeries, diagnostic procedures and tests in an effort to help the NHS reduce waiting times.

NHSN Risk Index

The Centres for Disease Control and Prevention National Healthcare Safety Network (NHSN) Risk Index assesses a patient's risk of developing an SSI based on the presence of 3 key risk factors (ASA score, duration of operation, and wound class). Patients are assigned a cumulative score from 0 to 3 based on the following: an ASA score of 3 or more, duration of surgery exceeding the 75th percentile, and a contaminated or dirty wound class. A score of 3 would indicate a high risk of SSI for a patient after an operation.

Risk ratio

A measure of the risk of a certain event happening in one group compared to the risk of the same event happening in another group. A risk ratio of one means there is no difference

between the 2 groups in terms of their risk, based on whether or not they were exposed to a certain factor or possess a certain risk factor. A risk ratio of less than 1 usually means that being exposed to a certain factor or possessing a certain risk factor decreases the risk of infection. A risk ratio greater than 1 means that being exposed to a certain factor or possessing a certain risk factor increases the risk of infection.

T-time

T-time represents the expected duration for a particular surgical procedure based on the 75th percentile for the duration of all such procedures, rounded to the nearest hour. T-times for all surgical categories are as follows:

Table 6. T-time for surgical categories

Surgical category	T-time (hours)
Abdominal hysterectomy	2
Bile duct, liver, or pancreatic surgery	5
Breast surgery	3
Cholecystectomy	2
Cardiac surgery (non-CABG)	5
Coronary artery bypass graft	5
Cranial surgery	4
Gastric surgery	3
Hip replacement	2
Knee replacement	2
Large bowel surgery	3
Limb amputation	1
Reduction of long bone fracture	2
Repair of neck of femur	1.5*
Small bowel surgery	3
Spinal surgery	3
Vascular surgery	3

* T-time derived from SSISS data.

Wound class

This describes the degree of wound contamination at the time of the operation, based on an international standard classification system. The classification ranges from W1 denoting a clean uninfected wound outside the respiratory, alimentary, and genital or urinary tract to W4 denoting dirty or infected wounds and include operations in which acute inflammation with pus is encountered or in which perforated viscera are found.

Appendix 1

Table 7. Requirements for data fields that inform patient and surgery-related characteristics

Characteristic	Requirement
Patient age	Calculated from mandatory date of birth and date of operation data fields
Patient sex	Mandated for submission, however “unknown” is an available response option
Patient BMI	Calculated from optional height and weight data fields
Patient ASA score	Mandated for submission, however “unknown” is an available response option
Wound class	Mandated for submission, however “unknown” is an available response option
Operation duration	Mandated for submission
Pre-operative stay	Calculated from mandatory date of admission and date of operation data fields
Elective surgery	Mandated for submission, however “missing” is an available response option
Trauma surgery	Mandated for submission, however “missing” is an available response option
Primary indication for surgery	Mandated for submission, however “unknown” is an available response option
Antibiotic prophylaxis given	Mandated for submission, however “unknown” is an available response option

Appendix 2

Table 8. Data completeness for patient and surgical characteristic variables, NHS hospitals England, April 2022 to March 2023

Surgical category	Number of hospitals	Number of operations	Patient-related characteristics				Surgery-related characteristics							
			Age (%)	Sex (%)	BMI* (%)	ASA score (%)	Wound class (%)	Operation duration (%)	Pre-op stay (%)	Elective surgery (%)	Trauma surgery* (%)	Primary indication (%)	Antibiotic prophylaxis (%)	
Abdominal hysterectomy	4	272	100.0	100.0	88.2	98.2	100.0	100.0	100.0	100.0	100.0	71.3	-	97.4
Bile duct, liver or pancreatic surgery	1	164	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	98.2
Breast surgery	15	2,597	99.9	100.0	72.2	95.6	100.0	100.0	100.0	100.0	100.0	99.8	-	93.1
Cardiac surgery (non-CABG)	8	3,321	100.0	100.0	82.4	69.5	100.0	99.9	100.0	100.0	100.0	99.9	-	99.9
Cholecystectomy	2	205	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0
Coronary artery bypass graft	13	6,065	100.0	99.9	84.8	76.1	100.0	100.0	100.0	100.0	100.0	99.9	-	99.9
Cranial surgery	3	1,050	100.0	100.0	81.5	85.0	100.0	100.0	100.0	100.0	100.0	99.5	-	98.8
Gastric surgery	4	282	100.0	100.0	64.2	97.2	100.0	100.0	100.0	100.0	100.0	100.0	-	97.5
Hip replacement	150	39,124	100.0	100.0	66.7	98.3	99.6	99.9	100.0	100.0	100.0	2.0	98.7	95.7
Knee replacement	138	38,317	100.0	100.0	67.4	98.7	99.4	99.9	100.0	100.0	100.0	2.0	98.3	95.1
Large bowel surgery	18	2,405	100.0	100.0	63.7	94.8	97.7	100.0	100.0	100.0	100.0	85.7	-	98.1
Limb amputation	4	187	100.0	100.0	64.7	98.4	99.5	100.0	100.0	100.0	100.0	99.5	-	100.0
Reduction of long bone fracture	26	4,098	100.0	100.0	30.1	97.5	100.0	100.0	100.0	100.0	100.0	91.9	98.4	93.5
Repair of neck of femur	75	20,486	100.0	100.0	32.0	94.8	99.1	100.0	100.0	100.0	100.0	2.4	-	97.2
Small bowel surgery	6	462	100.0	100.0	42.2	97.6	97.2	100.0	100.0	100.0	100.0	99.6	-	98.3
Spinal surgery	14	5,696	100.0	100.0	72.3	99.2	100.0	100.0	100.0	100.0	100.0	71.6	-	88.7
Vascular surgery	3	364	100.0	100.0	92.6	98.4	100.0	100.0	100.0	100.0	100.0	99.7	-	100.0

* Optional data entry field.

Abbreviations

BMI = body mass index

ASA = American Society of Anesthesiologists

op = operation

CI = confidence interval

Appendix 3

Table 9. Median BMI and proportion of paediatric patients by surgical category, NHS hospitals England, April 2022 to March 2023

Surgical category	Patient-related characteristics	
	Median BMI, IQR (kg/m ²)	Paediatric patients (%)
Abdominal hysterectomy	28.3 (23.7 - 33.3)	0.0
Bile duct, liver or pancreatic surgery	-	0.0
Breast surgery	27.5 (24.0 - 32.0)	0.2
Cardiac surgery (non-CABG)	27.3 (24.2 - 30.8)	5.6
Cholecystectomy	-	0.0
Coronary artery bypass graft	27.9 (25.0 - 31.2)	0.0
Cranial surgery	27.4 (24.2 - 31.7)	0.9
Gastric surgery	29.3 (25.3 - 35.1)	0.0
Hip replacement	28.4 (25.0 - 32.5)	0.0
Knee replacement	30.9 (27.4 - 34.9)	0.0
Large bowel surgery	26.8 (23.4 - 30.8)	0.8
Limb amputation	26.1 (22.1 - 30.1)	0.0
Reduction of long bone fracture	25.1 (21.7 - 28.8)	4.4
Repair of neck of femur	23.1 (20.2 - 26.3)	0.1
Small bowel surgery	26.2 (22.4 - 30.1)	7.4
Spinal surgery	28.4 (24.9 - 32.7)	11.0
Vascular surgery	26.8 (23.7 - 30.0)	0.0

Abbreviations

BMI = body mass index

IQR = interquartile range

Appendix 4

Table 10. Inpatient and readmission SSI risk by surgical category and ethnic group, NHS hospitals England, April 2022 to March 2023

Surgical category	Inpatient and readmission											
	Asian*		Black**		Other ethnic group†		Mixed or multiple ethnic groups‡		White†		Missing or unknown/not stated	
	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI
Abdominal hysterectomy§	1 37	2.7 (0.1-14.2)	0 36	0.0 (0.0-9.7)	0 9	0.0 (0.0-33.6)	0 12	0.0 (0.0-26.5)	13 953	1.4 (0.7-2.3)	3 55	5.5 (1.1-15.1)
Bile duct, liver or pancreatic surgery§	7 19	36.8 (16.3-61.6)	3 12	27.3 (6.0-61.0)	1 1	100.0 (2.5-100.0)	1 7	14.3 (0.4-57.9)	122 729	16.9 (14.2-19.8)	13 34	30.2 (17.2-46.1)
Breast surgery	1 307	0.3 (0.0-1.8)	0 165	0.0 (0.0-2.2)	0 35	0.0 (0.0-10.0)	3 85	2.4 (0.3-8.2)	76 11,712	0.6 (0.5-0.8)	4 1,001	0.4 (0.1-1.0)
Cardiac surgery (non-CABG)	11 1,430	0.8 (0.4-1.4)	8 517	1.5 (0.7-3.0)	0 109	0.0 (0.0-3.3)	2 149	1.3 (0.2-4.8)	163 13,611	1.2 (1.0-1.4)	14 1,114	1.3 (0.7-2.1)
Cholecystectomy§	0 11	0.0 (0.0-28.5)	0 6	0.0 (0.0-45.9)	0 2	0.0 (0.0-84.2)	0 2	0.0 (0.0-84.2)	26 327	8.0 (5.3-11.4)	1 33	3.0 (0.1-15.8)
Coronary artery bypass graft	122 5,002	2.4 (2.0-2.9)	16 508	3.1 (1.8-5.1)	6 251	2.4 (0.9-5.1)	5 228	2.2 (0.7-5.0)	570 20,106	2.8 (2.6-3.1)	18 1,465	1.2 (0.7-1.9)
Cranial surgery§	2 290	0.7 (0.1-2.5)	2 305	0.7 (0.1-2.3)	1 46	2.2 (0.1-11.5)	0 76	0.0 (0.0-4.7)	74 5,191	1.4 (1.1-1.8)	1 319	0.3 (0.0-1.7)
Gastric surgery§	1 15	6.7 (0.2-31.9)	0 16	0.0 (0.0-20.6)	1 2	50.0 (1.3-98.7)	1 11	9.1 (0.2-41.3)	18 948	1.9 (1.1-3.0)	3 86	3.5 (0.7-9.9)
Hip replacement	4 1,506	0.3 (0.1-0.7)	6 2,137	0.3 (0.1-0.6)	0 346	0.0 (0.0-1.1)	4 641	0.6 (0.2-1.6)	758 160,666	0.5 (0.4-0.5)	33 9,003	0.4 (0.3-0.5)
Knee replacement	22 8,995	0.2 (0.2-0.4)	12 3,444	0.3 (0.2-0.6)	2 428	0.5 (0.1-1.7)	6 778	0.8 (0.3-1.7)	602 153,450	0.4 (0.4-0.4)	17 7,031	0.2 (0.1-0.4)
Large bowel surgery	16 140	11.4 (6.7-17.9)	12 97	12.4 (6.6-20.6)	2 32	6.3 (0.8-20.8)	5 64	7.8 (2.6-17.3)	795 9,494	8.4 (7.8-9.0)	63 708	8.9 (6.9-11.3)
Limb amputation§	0 14	0.0 (0.0-23.2)	0 11	0.0 (0.0-28.5)	0 0	- (0.0-28.5)	0 1	0.0 (0.0-97.5)	20 548	3.6 (2.2-5.6)	1 29	3.4 (0.1-17.8)
Reduction of long bone fracture	1 273	0.4 (0.0-2.0)	4 188	2.1 (0.6-5.4)	2 97	2.1 (0.3-7.3)	1 104	1.0 (0.0-5.2)	94 13,928	0.7 (0.5-0.8)	3 897	0.3 (0.1-1.0)
Repair of neck of femur	3	0.3	1	0.3	3	1.6	2	0.9	644	0.7	43	0.9

Surgical category	Inpatient and readmission											
	Asian*		Black**		Other ethnic group†		Mixed or multiple ethnic groups‡		White†		Missing or unknown/not stated	
	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI	No. of SSI and op	SSI risk (%), 95% CI
	939	(0.1-0.9)	321	(0.0-1.7)	191	(0.3-4.5)	233	(0.1-3.1)	87,320	(0.7-0.8)	4,689	(0.7-1.2)
Small bowel surgery	8	12.7	3	8.1	0	0.0	0	0.0	145	7.8	7	6.5
	63	(5.6-23.5)	37	(1.7-21.9)	11	(0.0-28.5)	18	(0.0-18.5)	1,859	(6.6-9.1)	108	(2.6-12.9)
Spinal surgery	20	1.6	9	1.0	1	0.9	3	0.9	317	1.2	10	0.9
	1,232	(1.0-2.5)	866	(0.5-2.0)	110	(0.0-5.0)	321	(0.2-2.7)	26,267	(1.1-1.3)	1,155	(0.4-1.6)
Vascular surgery§	0	0.0	0	0.0	0	0.0	0	0.0	60	2.0	6	3.6
	14	(0.0-23.2)	7	(0.0-41.0)	8	(0.0-36.9)	17	(0.0-19.5)	2,957	(1.6-2.6)	166	(1.3-7.7)

§ Surgical categories with fewer than 5 participating hospitals. Results should be interpreted with caution

* Indian (Asian or Asian British), Pakistani (Asian or Asian British), Bangladeshi (Asian or Asian British), Chinese (other ethnic group) and any other Asian background

** Caribbean (black or black British), African (black or black British) and any other black background

† Any other ethnic group

‡ White and black Caribbean (mixed), white and black African (mixed), white and Asian (mixed), and any other mixed background

† British (white), Irish (white) and any other white background

Abbreviations

No. = number

op = operations

CI = confidence interval

Appendix 5

Table 11. Patient distribution by IMD deciles and surgical category, NHS hospitals England, April 2018 to March 2023

Surgical category	1 No. (%)	2 No. (%)	3 No. (%)	4 No. (%)	5 No. (%)	6 No. (%)	7 No. (%)	8 No. (%)	9 No. (%)	10 No. (%)	Missing No. (%)
Abdominal hysterectomy	85 (7.7)	89 (8.1)	100 (9.1)	132 (12.0)	127 (11.5)	117 (10.6)	124 (11.2)	105 (9.5)	75 (6.8)	62 (5.6)	88 (8.0)
Bile duct, liver or pancreatic surgery	62 (7.6)	59 (7.2)	61 (7.4)	73 (8.9)	79 (9.6)	86 (10.5)	94 (11.5)	105 (12.8)	76 (9.3)	95 (11.6)	29 (3.5)
Breast surgery	686 (5.1)	900 (6.7)	1,089 (8.2)	1,235 (9.2)	1,433 (10.7)	1,747 (13.1)	1,589 (11.9)	1,512 (11.3)	1,555 (11.6)	1,385 (10.4)	221 (1.7)
Cardiac surgery (non-CABG)	678 (3.9)	1,226 (7.1)	1,458 (8.4)	1,533 (8.9)	1,718 (10.0)	1,712 (9.9)	1,786 (10.3)	1,908 (11.1)	1,907 (11.1)	2,281 (13.2)	1,050 (6.1)
Cholecystectomy	35 (9.0)	33 (8.5)	33 (8.5)	31 (8.0)	35 (9.0)	46 (11.8)	45 (11.6)	45 (11.6)	36 (9.3)	40 (10.3)	10 (2.6)
Coronary artery bypass graft	1,356 (4.8)	2,479 (8.8)	2,765 (9.8)	2,858 (10.1)	2,992 (10.6)	2,906 (10.3)	2,845 (10.1)	2,990 (10.6)	2,986 (10.6)	3,272 (11.6)	759 (2.7)
Cranial surgery	633 (9.9)	720 (11.2)	672 (10.5)	614 (9.6)	657 (10.2)	640 (10.0)	616 (9.6)	585 (9.1)	592 (9.2)	469 (7.3)	223 (3.5)
Gastric surgery	76 (6.9)	68 (6.2)	92 (8.4)	80 (7.3)	127 (11.6)	151 (13.7)	135 (12.3)	128 (11.6)	111 (10.1)	111 (10.1)	20 (1.8)
Hip replacement	10,799 (6.2)	12,577 (7.2)	13,899 (7.9)	16,572 (9.4)	18,235 (10.4)	18,963 (10.8)	19,057 (10.9)	18,783 (10.7)	18,630 (10.6)	17,292 (9.9)	10,625 (6.1)
Knee replacement	11,951 (6.8)	14,434 (8.2)	15,376 (8.8)	17,299 (9.9)	18,387 (10.5)	18,501 (10.6)	18,831 (10.8)	18,199 (10.4)	17,491 (10.0)	15,785 (9.0)	8,820 (5.0)
Large bowel surgery	549 (5.2)	621 (5.8)	858 (8.1)	915 (8.6)	1,236 (11.6)	1,347 (12.7)	1,370 (12.9)	1,175 (11.0)	1,210 (11.4)	1,140 (10.7)	225 (2.1)
Limb amputation	121 (19.8)	142 (23.2)	97 (15.9)	83 (13.6)	45 (7.4)	34 (5.6)	24 (3.9)	23 (3.8)	23 (3.8)	6 (1.0)	13 (2.1)
Reduction of long bone fracture	1,979 (12.2)	1,389 (8.6)	1,555 (9.6)	1,966 (12.1)	1,572 (9.7)	1,672 (10.3)	1,637 (10.1)	1,405 (8.7)	1,329 (8.2)	1,121 (6.9)	561 (3.5)
Repair of neck of femur	7,907 (8.3)	7,989 (8.4)	8,206 (8.6)	8,909 (9.4)	9,311 (9.8)	10,119 (10.6)	10,476 (11.0)	9,878 (10.4)	10,335 (10.9)	9,971 (10.5)	2,020 (2.1)
Small bowel surgery	158 (7.4)	126 (5.9)	148 (6.9)	158 (7.4)	225 (10.5)	225 (10.5)	241 (11.3)	266 (12.5)	287 (13.4)	239 (11.2)	62 (2.9)
Spinal surgery	2,284	2,830	2,806	3,107	3,124	2,928	2,929	2,756	2,874	2,857	2,294

Surgical category	1 No. (%)	2 No. (%)	3 No. (%)	4 No. (%)	5 No. (%)	6 No. (%)	7 No. (%)	8 No. (%)	9 No. (%)	10 No. (%)	Missing No. (%)
	(7.4)	(9.2)	(9.1)	(10.1)	(10.1)	(9.5)	(9.5)	(9.0)	(9.3)	(9.3)	(7.5)
Vascular surgery	447 (13.8)	403 (12.4)	312 (9.6)	312 (9.6)	294 (9.1)	319 (9.8)	269 (8.3)	265 (8.2)	283 (8.7)	159 (4.9)	181 (5.6)

No. = number

Appendix 6

Table 12. Inpatient and readmission SSI risk by surgical category and IMD decile, NHS hospitals England, April 2022 to March 2023

Surgical category	Inpatient and readmission																			
	1		2		3		4		5		6		7		8		9		10	
	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI
Abdominal hysterectomy*	5	5.9 (1.9-13.2)	2	2.3 (0.3-7.9)	0	0.0 (0.0-3.6)	1	0.8 (0.0-4.2)	1	0.8 (0.0-4.3)	2	1.7 (0.2-6.0)	1	0.8 (0.0-4.4)	3	2.9 (0.6-8.1)	1	1.3 (0.0-7.2)	0	0.0 (0.0-5.8)
Bile duct, liver or pancreatic surgery*	9	14.5 (6.9-25.8)	10	17.0 (8.4-29.0)	8	13.1 (5.8-24.2)	13	17.8 (9.8-28.5)	17	21.5 (13.1-32.2)	14	16.3 (9.2-25.8)	12	12.8 (6.8-21.2)	13	12.4 (6.8-20.2)	15	19.7 (11.5-30.5)	21	22.1 (14.2-31.8)
Breast surgery	9	1.3 (0.6-2.5)	4	0.4 (0.1-1.1)	7	0.6 (0.3-1.3)	6	0.5 (0.2-1.1)	9	0.6 (0.3-1.2)	5	0.3 (0.1-0.7)	14	0.9 (0.5-1.5)	12	0.8 (0.4-1.4)	11	0.7 (0.4-1.3)	6	0.4 (0.2-0.9)
Cardiac surgery (non-CABG)	11	1.6 (0.8-2.9)	19	1.6 (0.9-2.4)	19	1.3 (0.8-2.0)	15	1.0 (0.6-1.6)	16	0.9 (0.5-1.5)	20	1.2 (0.7-1.8)	18	1.0 (0.6-1.6)	17	0.9 (0.5-1.4)	20	1.1 (0.6-1.6)	17	0.8 (0.4-1.2)
Cholecystectomy*	1	2.9 (0.1-14.9)	1	3.0 (0.1-15.8)	3	9.1 (1.9-24.3)	3	9.7 (2.0-25.8)	4	11.4 (3.2-26.7)	4	8.7 (2.4-20.8)	4	8.9 (2.5-21.2)	2	4.4 (0.5-15.2)	3	8.3 (1.8-22.5)	2	5.0 (0.6-16.9)
Coronary artery bypass graft	45	3.3 (2.4-4.4)	72	2.9 (2.3-3.6)	63	2.3 (1.8-2.9)	72	2.5 (2.0-3.2)	78	2.6 (2.1-3.2)	79	2.7 (2.2-3.4)	72	2.5 (2.0-3.2)	77	2.6 (2.0-3.2)	73	2.4 (1.9-3.1)	63	1.9 (1.5-2.5)
Cranial surgery*	8	1.3 (0.6-2.5)	16	2.2 (1.3-3.6)	10	1.5 (0.7-2.7)	4	0.7 (0.2-1.7)	8	1.2 (0.5-2.4)	7	1.1 (0.4-2.2)	8	1.3 (0.6-2.5)	4	0.7 (0.2-1.7)	5	0.8 (0.3-2.0)	9	1.9 (0.9-3.6)
Gastric surgery*	1	1.3 (0.0-7.1)	1	1.5 (0.0-7.9)	0	0.0 (0.0-3.9)	1	1.3 (0.0-6.8)	3	2.4 (0.5-6.8)	4	2.7 (0.7-6.6)	5	3.7 (1.2-8.4)	3	2.3 (0.5-6.7)	1	0.9 (0.0-4.9)	2	1.8 (0.2-6.4)
Hip replacement	52	0.5 (0.4-0.6)	64	0.5 (0.4-0.7)	71	0.5 (0.4-0.6)	73	0.4 (0.4-0.6)	103	0.6 (0.5-0.7)	82	0.4 (0.3-0.5)	95	0.5 (0.4-0.6)	80	0.4 (0.3-0.5)	86	0.5 (0.4-0.6)	69	0.4 (0.3-0.5)
Knee replacement	56	0.5 (0.4-0.6)	55	0.4 (0.3-0.5)	50	0.3 (0.2-0.4)	61	0.4 (0.3-0.5)	83	0.5 (0.4-0.6)	66	0.4 (0.3-0.5)	69	0.4 (0.3-0.5)	80	0.4 (0.4-0.6)	64	0.4 (0.3-0.5)	50	0.3 (0.2-0.4)
Large bowel surgery	64	11.7 (9.1-14.6)	51	8.2 (6.2-10.7)	65	7.6 (5.9-9.6)	81	8.9 (7.1-10.9)	97	7.9 (6.4-9.5)	109	8.1 (6.7-9.7)	99	7.2 (5.9-8.7)	96	8.2 (6.7-9.9)	103	8.5 (7.0-10.2)	95	8.3 (6.8-10.1)
Limb amputation*	4	3.3 (0.9-8.3)	6	4.2 (1.6-9.0)	4	4.1 (1.1-10.2)	4	4.8 (1.3-11.9)	0	0.0 (0.0-7.9)	1	2.9 (0.1-15.3)	0	0.0 (0.0-14.3)	1	4.4 (0.1-22.0)	0	0.0 (0.0-14.8)	1	16.7 (0.4-64.1)
Reduction of long bone fracture	19	1.0 (0.6-1.5)	13	0.9 (0.5-1.6)	12	0.8 (0.4-1.3)	11	0.6 (0.3-1.0)	8	0.5 (0.2-1.0)	7	0.4 (0.2-0.9)	14	0.9 (0.5-1.4)	7	0.5 (0.2-1.0)	7	0.5 (0.2-1.1)	8	0.7 (0.3-1.4)

Surgical category	Inpatient and readmission																			
	1		2		3		4		5		6		7		8		9		10	
	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI	No. of SSI	SSI risk (%), 95% CI
Repair of neck of femur	71	0.9 (0.7-1.1)	56	0.7 (0.5-0.9)	63	0.8 (0.6-1.0)	61	0.7 (0.5-0.9)	70	0.8 (0.6-1.0)	63	0.6 (0.5-0.8)	72	0.7 (0.5-0.9)	61	0.6 (0.5-0.8)	72	0.7 (0.6-0.9)	92	0.9 (0.7-1.1)
Small bowel surgery	14	8.9 (4.9-14.4)	9	7.1 (3.3-13.1)	9	6.1 (2.8-11.2)	7	4.4 (1.8-8.9)	24	10.7 (7.0-15.5)	11	4.9 (2.5-8.6)	25	10.4 (6.8-14.9)	14	5.3 (2.9-8.7)	24	8.4 (5.4-12.2)	19	8.0 (4.9-12.1)
Spinal surgery	31	1.4 (0.9-1.9)	30	1.1 (0.7-1.5)	46	1.6 (1.2-2.2)	44	1.4 (1.0-1.9)	35	1.1 (0.8-1.6)	26	0.9 (0.6-1.3)	33	1.1 (0.8-1.6)	35	1.3 (0.9-1.8)	25	0.9 (0.6-1.3)	40	1.4 (1.0-1.9)
Vascular surgery*	8	1.8 (0.8-3.5)	14	3.5 (1.9-5.8)	9	2.9 (1.3-5.4)	9	2.9 (1.3-5.4)	1	0.3 (0.0-1.9)	5	1.6 (0.5-3.6)	2	0.7 (0.1-2.7)	9	3.4 (1.6-6.4)	4	1.4 (0.4-3.6)	1	0.6 (0.0-3.5)

* Surgical categories with fewer than 5 participating hospitals. Results should be interpreted with caution

Abbreviations

No. = number

CI = confidence interval

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