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Impact of the COVID-19 Pandemic on the Management of Groin Hernia Repairs

A Nationwide Population-Based Study From the Swedish Hernia Register

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Objective: The aim is to assess the impact of COVID-19 pandemic on delays in elective surgeries for symptomatic groin hernias in Sweden.

Background: In Sweden, over 16,000 groin hernia repairs are performed annually, primarily in elective daycare settings. The COVID-19 pandemic led to the temporary postponement of all elective surgeries to reallocate healthcare resources and limit viral transmission.

Methods: This nationwide population-based study utilizing data from the Swedish Hernia Register compared groin hernia repairs before (2015–2019) and during (2020–2021) the pandemic. Multivariable logistic regression analysis stratified by gender was employed for the outcomes. The main outcomes were risks of emergency repair, severe complications (Clavien–Dindo ≥3b), 30-day mortality, and reoperation for recurrence.

Results: A total of 109,459 groin hernia repairs (n = 98 156 in men and n = 11 303 in women) were analyzed. The number of elective repairs declined by 22.9%, while emergency repairs only increased by 2.2% in 2020. Women had a higher risk of emergency repair during the pandemic (odds ratio: 1.38, $P < 0.001$) and presented notably higher crude rates of 30-day mortality and bowel resection compared with men in both cohorts. However, the overall risks in the population remained stable despite these shifts.

Conclusions: "Watchful waiting" for symptomatic groin hernias due to postponement of elective repairs in men appears safe regarding the risks of emergency repair and severe complications, in contrary to women. While elective repairs can temporally be deferred during crises, careful consideration should be given to women. Given this large-scale study, watchful waiting may not be appropriate for women in future healthcare crises, warranting further investigations.

Keywords: acute hernia repair, COVID pandemic, elective hernia repair, groin hernia repair, register study

INTRODUCTION

At the onset of 2020, the severe acute respiratory syndrome coronavirus 2 (COVID-19) pandemic rapidly spread across the globe, and by the end of 2022, over 700 million confirmed cases of COVID-19 had been reported, with more than 6 million deaths attributable to the pandemic.[1] In response, Swedish hospitals swiftly canceled all elective benign surgeries, such as hernia repairs and cholecystectomies, to reallocate critical health resources (eg, ventilators, masks) and to minimize the spread of the infection.[2]

In Sweden, more than 16,000 groin hernias are recorded annually in the Swedish Hernia Register (SHR). The majority of these procedures are elective, mainly performed as day surgeries, and private hospitals are included in the publicly

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The preliminary of the present study has been presented at the Swedish Hernia Days in Stockholm (March 2024), at the annual European Hernia Society Meeting 2024 in Prag (May 2024), and at the Swedish Annual Surgical Meeting in Karlstad (August 2024).

The original contributions presented in the study are included in the article/supplementary material. All data are uncoded and can be provided on request. Further inquiries can be directed to the corresponding author.

The study was approved by the Regional Ethical Committee in Gothenburg, Sweden representing the Swedish Ethical Review Authority with reference numbers 369-363 and amendment 2022-06952-01. The study was conducted in accordance with all local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with national legislation and institutional requirements.

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TABLE 1.

Baseline Patient Characteristics in Groin Hernia Repairs in Sweden During the Pre-COVID (2015–2019) and COVID (2020–2021) Periods

	Men*†		Women*†	
Time Period	**Pre-COVID**	**COVID**	**Pre-COVID**	**COVID**
No. patients	67,259	23,256	7752	2593
No. repairs	72,999	25,157	8446	2857
Age, y, mean (SD)	62.6 (14.8)	62.9 (14.8)	62.5 (17.4)	63.1 (17.2)
Admission mode per patient				
Acute repair	2881 (4.3)	1173 (5.0)	983 (12.7)	406 (15.7)
Elective repair	64,377 (95.7)	22,083 (95.0)	6769 (87.3)	2187 (84.3)
Type of repair‡				
Bilateral	5825 (8.7)	1924 (8.3)	699 (9.0)	265 (10.2)
Unilateral	61,434 (91.3)	21,332 (91.7)	7053 (91.0)	2328 (89.8)
ASA fitness grade§				
ASA I–II	57,876 (86)	19,936 (85.7)	6604 (85.2)	2175 (83.9)
ASA III	8940 (13.3)	3175 (13.7)	1075 (13.9)	385 (14.8)
ASA IV–V	443 (0.7)	144 (0.6)	73 (0.9)	33 (1.3)
Smoking				
Yes	3234 (4.8)	1008 (4.3)	359 (4.6)	117 (4.5)
No	64,025 (95.2)	22,248 (95.7)	7393 (95.4)	2476 (95.5)

*Nominal and ordinal characteristics are reported as frequency. Percentages are presented in parentheses unless indicated otherwise.

†Missing values below 0.01% are not reported.

‡Bilateral repairs are calculated as 2 separate repairs per patient.

§The ASA physical fitness grade refers to the Physical status classification system adopted in 1963 by the American Society of Anesthesiologists. Grade I–II refer to persons who are healthy or suffering from mild systemic disease, and grade III–IV refers to persons who are suffering from severe systemic diseases some of which are life-threatening.

funded health system.[3] The SHR, with over 400,000 prospectively registered groin hernias without selection bias of surgical expertise, a nearly total national coverage, and a data validation level of 98%, has played a pivotal role in enhancing the quality of hernia surgery both in Sweden and internationally.[4]

Watchful waiting has been established as a safe approach for asymptomatic inguinal hernias in men, without increasing the risk of emergency surgery or mortality.[5,6] Nearly 75% of these individuals eventually develop symptoms, necessitating a surgical approach at a later date.[7,8] However, the safety and outcomes of watchful waiting for symptomatic groin hernias in men and even more importantly in women have not yet been adequately studied, particularly on a national scale in terms of mortality and morbidity risks.

This study aimed to assess the impact of delayed groin hernia surgeries due to the COVID-19 pandemic through a nationwide population-based cohort study. Specifically, our primary aim was to compare the risks of emergency hernia repair in the population dichotomized by gender before and during the pandemic. The secondary aims were to analyze the risks of severe complications (Clavien–Dindo ≥3b), 30-day mortality, and reoperation for recurrence between both sexes. We hypothesized that postponement of elective surgeries may have led to an increased number of emergency hernia repairs, accompanied by a higher risk of postoperative complications.

METHOD

This nationwide, population-based observational study is based on the prospectively registered data from the SHR and presented according to the Strengthening the Reporting of Observational Studies in Epidemiology checklist.[9] The study included all individuals older than 15 years who have undergone groin hernia repair and were prospectively registered in the SHR between January 1, 2015, and December 31, 2021. Ethical approval was obtained from the Swedish Ethical Review Authority before data collection from the SHR (Dnr 2022-06952-01).

Swedish Hernia Register

The SHR was established in 1992 and achieved a total national coverage by 2004. Data are prospectively registered for all groin hernia repairs in men and women aged >15 years. Although participation is nonmandatory and individuals are entitled to withdraw their consent, the register maintains a high completeness rate of 94% to 97% of all hernia repairs in Sweden.[10] To date, over 400,000 hernia repairs have been prospectively registered, creating a unique and valuable database for both research and quality feedback to participating units. The primary quality indicators in the SHR include the risk of reoperation for recurrence and the occurrence of complications within 30 days, as classified by the Clavien–Dindo system.[11] Each year, an external reviewer from the SHR visits approximately 10% of participating units by comparing the register data with the hospital's medical and operative records. All patients are followed from their index operation until reoperation for recurrence, emigration, or death.

Data Extraction and Statistical Analyses

The study period was divided into 2 phases: pre-COVID (2015–2019) and COVID (2020–2021), with further stratification by gender (Table 1). The inclusion of 2021 was due to an increased number of COVID-infected individuals in the autumn, prompting renewed restrictions in Sweden. Anonymized data including age, gender, comorbidities, hernia anatomy, surgical indication, primary versus secondary repair, type of anesthesia, surgical techniques, and reported complications within 30 days were extracted from the SHR (Tables 1, 2, and 5). Bilateral repairs were accounted for as 2 separate repairs per patient. A chi-square test was applied for the correlation between categorical variables (Tables 2 and 5). Data on reoperation for recurrence (ie, subsequent hernia repair in the previously operated groin and registered in the SHR) were collected up to December 31, 2022, ensuring a minimum of 1 year of follow-up for patients operated on at the end of the study period (December 2021).

The mean waiting time for the surgery was categorized as either less than 3 months or 3 months or more. Comorbidities were evaluated using the American Society of Anesthesiologists

TABLE 2.

Baseline Surgical Characteristics for Each Groin Hernia Repair Registered in the Swedish Hernia Register During the Pre-COVID (2015–2019) and COVID (2020–2021) Periods

	Men*†			Women*†		
Time Period	**Pre-COVID**	**COVID**	***P*‡**	**Pre-COVID**	**COVID**	***P*‡**
No. patients (n)	67,259	23,256	—	7752	2593	—
No. repairs (n)	72,999	25,157	—	8446	2857	—
Type of anesthesia§						
General	55,719 (82.9)	18,929 (81.4)	**<0.001**	7355 (94.9)	2439 (94.1)	0.071
Regional	1926 (2.9)	480 (2.1)		137 (1.8)	42 (1.6)	
Local	9614 (14.3)	3847 (16.5)		260 (3.4)	112 (4.3)	
Surgical method						
Open	52,038 (71)	15,859 (63)	**<0.001**	2557 (30)	679 (24)	**<0.001**
Laparo-endoscopic	20,956 (29)	9294 (37)		5889 (70)	2178 (76)	
Primary/recurrent hernia						
Primary repair	65,966 (90.4)	22,965 (91.3)	**<0.001**	8023 (95)	2734 (95.7)	0.301
Recurrent repair	6885 (9.4)	2157 (8.6)		399 (4.7)	117 (4.1)	
Missing	148 (0.2)	35 (0.1)		24 (0.3)	6 (0.2)	
Hernia anatomy						
Lateral/indirect hernia	39,015 (53.4)	13,873 (55.1)	**<0.001**	4394 (52)	1351 (47.3)	**<0.001**
Femoral hernia	1037 (1.4)	394 (2.0)		2050 (24.3)	740 (25.9)	
Combined hernia	6469 (8.9)	2274 (9.0)		192 (2.3)	72 (2.5)	
Medial/direct hernia	24,842 (34.0)	7757 (30.8)		1464 (17.3)	489 (17.1)	
Missing	1636 (2.0)	859 (3.4)		346 (4.1)	205 (7.2)	
Hernia defect size						
<1.5 cm	11,598 (15.9)	4115 (16.4)	**<0.001**	3516 (41.6)	1195 (41.8)	0.054
1.5–3 cm	39,761 (54.4)	14,067 (55.9)		4210 (49.8)	1465 (51.2)	
>3 cm	21,473 (29.4)	6905 (27.4)		701 (8.3)	192 (6.7)	
Missing	167 (0.2)	70 (0.3)		19 (0.2)	6 (0.2)	
Duration of surgery, min, mean (SD)	63.1 (30.2)	61.4 (30.6)		55.0 (27.9)	54.8 (30.5)	
Clavien–Dindo grade‖¶						
1–3a	5250 (7.2)	1891 (7.5)	0.989	590 (7.0)	210 (7.4)	0.667
3b–5	402 (0.6)	145 (0.6)		79 (0.9)	31 (1.1)	
Incarcerated bowel	431 (0.6)	197 (0.8)	0.077	279 (3.3)	136 (4.8)	0.818
Bowel resection	158 (0.2)	58 (0.2)		149 (1.8)	71 (2.5)	
Bowel reduction (only)	273 (0.4)	139 (0.6)		130 (1.5)	65 (2.3)	
Later recurrence						
Yes	2088 (2.9)	415 (1.6)	**<0.001**	143 (1.7)	25 (0.9)	**0.002**
No	70,911 (97.1)	24,742 (98.4)		8303 (98.4)	2832 (99.1)	
Waiting time§, mo, mean (SD)	2.2 (2.47)	3.3 (3.55)	—	2.5 (2.82)	3.4 (4.17)	—

*Nominal and ordinal characteristics are reported as frequency. Percentages are presented in parentheses unless indicated otherwise.

†Missing values below 0.01% are not reported.

‡A chi-square crosstabulation and Holm-Bonferronis test was performed for each categorical variable for men and women in the pre-COVID and COVID cohorts and presented as *P* values. Significant *P* values are in bold.

§The numbers are based on each patient registered in the Swedish Hernia Register.

‖Clavien–Dindo classification for postoperative complications and dichotomized into 2 subgroups: 1–3a requiring no surgical intervention, respectively; 3b–5 requiring surgical intervention.

¶One patient can have more than 1 complication for the same procedure.

TABLE 3.

Multivariable Logistic Regression Analysis of the Risk of Emergency Hernia Repair and Other Severe Adverse Events in Men and Women Undergoing Groin Hernia Repair in Sweden During the Pre-COVID (2018–2019) and COVID (2020–2021) Periods

	Men		Women	
Time Period	**COVID**	***P***	**COVID**	***P***
Risk of emergency hernia repair*	OR: 1.21 (95% CI: 1.11–1.32)	<0.001	OR: 1.38 (95% CI: 1.16–1.64)	<0.001
Risk of severe complication† (Clavien–Dindo grades 3b–5)	OR: 0.94 (95% CI: 0.75 –1.18)	0.588	OR: 0.88 (95% CI: 0.53–1.45)	0.606
Risk of 30-day mortality‡	OR: 1.17 (95% CI: 0.65–2.11)	0.591	OR: 1.07 (95% CI: 0.423–2.71)	0.887
Risk of reoperation for recurrence§	OR: 0.57 (95% CI: 0.49–0.66)	<0.001	OR: 0.52 (95% CI: 0.30–0.92)	0.024

*Adjustments were made for: age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), hernia anatomy (lateral as ref), and surgical method (open as ref).

†Adjustments were made for: age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), hernia anatomy (lateral as ref), mode of admission (elective as ref), surgical method (open as ref), and waiting time for surgery (<3 months as ref).

‡Adjustments were made for: age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), and mode of admission (elective as ref).

§Adjustments were made for: age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), hernia anatomy (lateral as ref), mode of admission (elective as ref), surgical method (open as ref), primary repair (yes as ref), and 30-day complication (no as ref).

TABLE 4.

Multivariable Logistic Regression Analysis of the Risk of Emergency Hernia Repair and Other Severe Adverse Events in the Overall Population Undergoing Groin Hernia Repair in Sweden During the Pre-COVID (2018–2019) and COVID (2020–2021) Periods

Time Period	Pre-COVID	COVID	*P*
Risk of emergency hernia repair*	1.0	OR: 1.24 (95% CI: 1.15–1.34)	<0.001
Risk of severe complication† (Clavien–Dindo grades 3b–5)	1.0	OR: 0.93 (95% CI: 0,79–1.11)	0.4
Risk of 30-day mortality‡	1.0	OR: 0.98 (95% CI: 0.67–1.43)	>0.9
Risk of reoperation for recurrence§	1.0	OR: 0.73 (95% CI: 0.64–0.82)	<0.001

*Adjustments were made for: gender (male as ref), age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4-5), hernia anatomy (lateral as ref), and surgical method (open as ref).
†Adjustments were made for: gender (male as ref), age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), hernia anatomy (lateral as ref), mode of admission (elective as ref), surgical method (open as ref), and waiting time for surgery (<3 months as ref).
‡Adjustments were made for: gender (male as ref), age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), and mode of admission (elective as ref).
§Adjustments were made for: gender (male as ref), age (<50 as ref, 50–70, >70 years), ASA score (1–2 as ref, 3, 4–5), hernia anatomy (lateral as ref), mode of admission (elective as ref), surgical method (open as ref), primary repair (yes as ref), and 30-day complication (no as ref).

(ASA) physical status classification, where patients with a body mass index >30 kg/m^2 were included in ASA group 2.[12] Smoking status was recorded as a binary variable (yes/no). Any combined groin hernia involving a femoral hernia was classified as femoral. Postoperative complications were categorized according to the Clavien–Dindo classification and dichotomized into 2o subgroups: 1–3a and 3b–5.[11] One patient can experience multiple complications per repairs, while adverse events during bilateral repair (eg, death, cardiopulmonary events, deep bleeding, sepsis, and bowel injury) were considered as a single complication per patient (Table 5). The proportion of incarcerated bowel with or without the need of a resection was analyzed separately (Table 2).

Multivariable logistic regression analyses were conducted separately for men and women, but also for the overall unstratified population, to estimate the odds ratios (ORs) for emergency hernia repairs, 30-day mortality, severe postoperative complications, and reoperation for recurrence (Tables 3 and 4). Only data from 2018 to 2019 and 2020 to 2021 were included in these logistic regression models and variables were selected using a theory-based approach, centered on the specific research question, and clinical relevance. Adjustment was made for gender, age, timing of surgery (acute vs elective), hernia anatomy, and comorbidities. The 95% confidence intervals (CI) were calculated, and statistical significance was set to $P < 0.05$. Statistical analyses were performed using IBM SPSS Statistics version 29.0.2.0, with missing data (<0.01%) excluded from reporting.

RESULTS

Between January 1, 2015, and December 31, 2021, a total of 100,860 individuals (90,515 men and 10,345 women) underwent a total of 109,459 groin hernia repairs, as recorded in the SHR (Table 1). Baseline patient characteristics for each period are presented in Table 1, and detailed surgical characteristics for each repair during the pre-COVID and COVID periods are demonstrated in Table 2.

The number of repairs per year in relation to admission type is shown in Figure 1A–C. During the initial 3 to 4 months of the COVID-19 pandemic, nearly all elective hernia surgeries were postponed, with numbers returning to expected levels by late

TABLE 5.

Postoperative Complications Within 30 Days in Patients Undergoing Groin Hernia Repair in Sweden During the Pre-COVID (2015–2019) and COVID (2020–2021) Periods

	Men*†			Women*†		
Time Period	Pre-COVID	COVID	*P*‡	Pre-COVID	COVID	*P*‡
No. hernia repairs	72,999	25,157	—	8446	2857	—
No. complications	7119 (9.8)	2376 (9.4)		859 (10.2)	291 (10.4)	
Death within 30 days	63 (0.9)	26 (1.1)	0.359	19 (2.2)	11 (3.8)	0.147
Bleeding						
Deep	289 (4.1)	93 (4.0)	0.250	34 (4.0)	8 (2.7)	0.835
Superficial	1 411 (19.8)	390 (16.4)		89 (10.3)	19 (6.5)	
Infection/abscess						
Deep	217 (3.5)	69 (3.0)	0.525	37 (4.3)	16 (5.5)	0.220
Superficial	732 (10.2)	257 (10.8)		88 (10.2)	24 (8.2)	
Bowel obstruction	58 (0.8)	21 (0.1)	0.748	37 (4.3)	21 (7.2)	**0.050**
Cardiopulmonary complication	180 (2.5)	39 (1.6)	**0.013**	33 (3.8)	13 (4.5)	0.638
Sepsis	100 (1.4)	35 (1.5)	0.807	20 (2.3)	9 (3.1)	0.472
Organ injury						
Bowel	23 (0.3)	9 (0.4)	0.914	10 (1.1)	4 (1)	0.838
Bladder	7 (0.1)	3 (0.1)		9 (1)	3 (1)	
Testicular	48 (0.7)	16 (0.7)		—	—	
Urinary retention	2433 (34.0)	922 (38.8)	**<0.001**	305 (35.5)	106 (36.4)	0.777
Urinary catheter§						
Intermittent	1056 (14.8)	324 (13.6)	**0.025**	152 (17.7)	48 (16.5)	0.853
Indwelling	1584 (20.3)	581 (24.5)		167 (19.4)	55 (19)	
Seroma	802 (11.2)	277 (11.7)	0.602	86 (10.0)	25 (8.6)	0.478
Postoperative pain	1087 (14.4)	441 (18.6)	**<0.001**	171 (19.9)	71 (24.4)	0.104
Recurrence within 30 days	139 (2.0)	35 (1.5)	0.131	12 (1.4)	5 (1.7)	0.695

*Nominal and ordinal characteristics are reported as frequency. Percentages are based on a total number of complications and presented in parentheses unless indicated otherwise.
†One patient can have more than 1 complication for the same procedure.
‡A chi-square crosstabulation and Holm-Bonferronis test was performed for each categorical variable for men and women in the pre-COVID and COVID cohorts, and presented as *P* values. Significant *P* values are in bold.
§Each catheter intervention is counted as a separate complication for each patient.

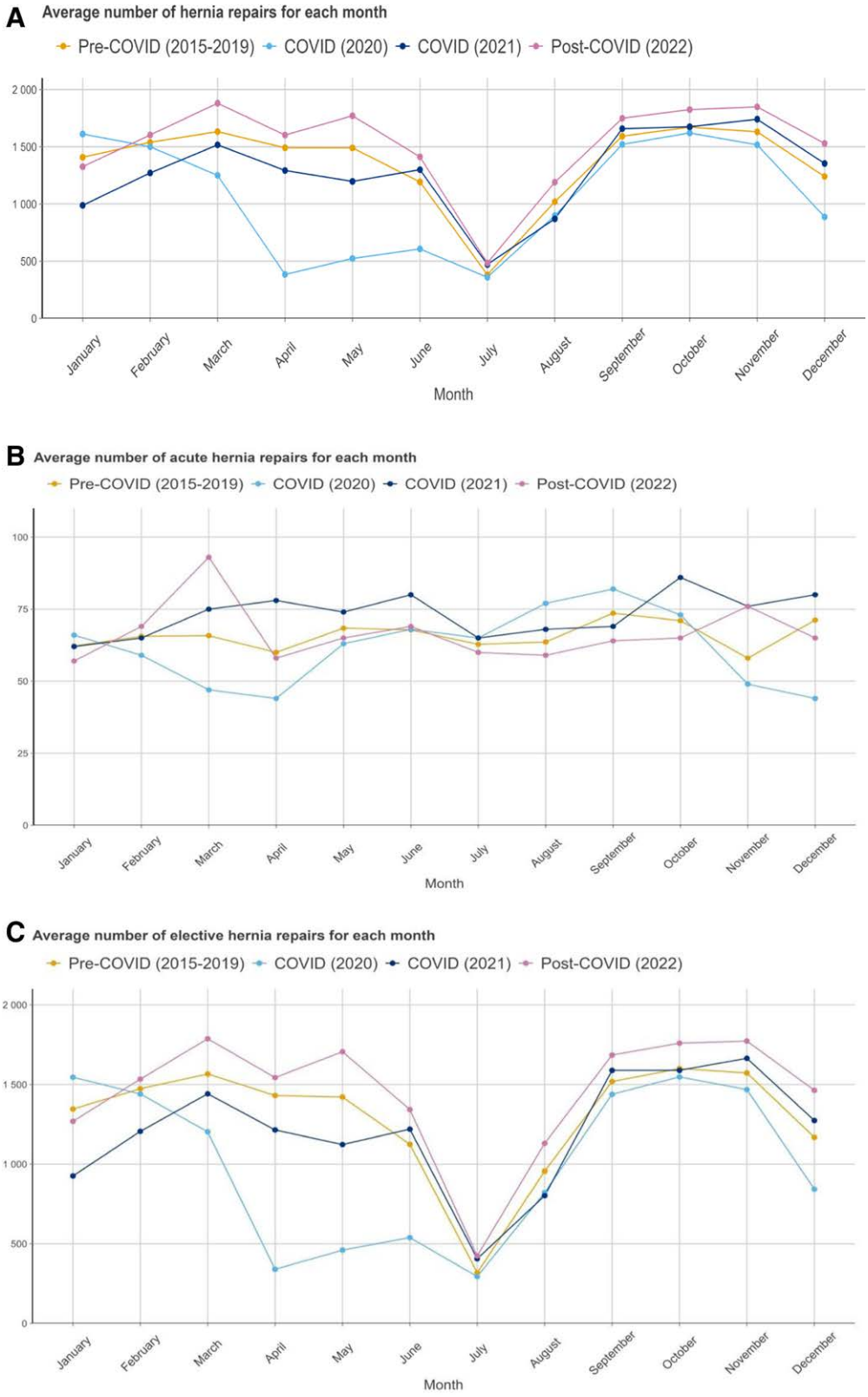

FIGURE 1. Average number of all groin hernia repairs in relation to the admission type during the pre-COVID (2015–2019) and COVID (2020–2021) periods: (A) average number of all groin hernia repairs; (B) average number of acute groin hernia repairs; and (C) average number of elective groin hernia repairs.

summer 2020 (Fig. 1C). Elective groin hernia repairs dropped to 11,944 in 2020, representing a 22.9% reduction compared with prepandemic levels (15,499 elective repairs per year on average).[10] The proportion of emergency hernia repairs was on average 4.8% before the pandemic but increased to 5.8% in 2020 (Fig. 1B). By the end of 2021, a total of 15,335 groin hernia repairs were registered, reaching 94% of prepandemic levels and with emergency repairs representing 5.7% of them. In 2022, the number of reported groin hernia repairs in SHR increased to 18,221, with the proportion of emergency repairs declining

back to 4.4%. The mean waiting time for surgery during the pandemic increased from 2.2 months to 3.3 months for men and from 2.5 months to 3.4 months for women.

The proportion of ASA scores >3 increased by 0.5 percentage units in the COVID cohort (0.3% for men with $P = 0.316$ and 1.3% for women with $P = 0.150$) (Table 1). Smoking rates declined by 0.5% in the overall population, with a significant reduction mainly among men ($P < 0.001$). Lateral hernias (1.5–3 cm defects, European Hernia Society L2) remained the most common type in both men and women (Table 2). Local anesthesia usage increased in men, and while open surgery was still the preferred method, the statistically significant trend toward laparo-endoscopic repairs continued (Table 2).

Risk of Emergency Surgery

Initially both elective and emergency hernia repairs decreased in 2020, but the numbers of emergency hernia repairs rose in early 2021 and 2022 (Fig. 1B). The overall proportion of acute repairs in the population increased from 4.8% prepandemic to 5.7% during COVID, with a significant rise of 0.7% in men and 3.0% in women ($P < 0.001$) (Table 1). The crude number of emergency hernia repairs in the overall population significantly increased by 1.1% ($P < 0.001$) during the pandemic (Table 1), with a notable increase in the OR for emergency surgeries (OR: 1.24, 95% CI: 1.15–1.34, $P < 0.001$) (Table 4).

Women in both cohorts presented with emergency hernia repairs up to 3 times more often than men (Table 2), particularly older women (>70 years) with higher comorbidities (OR: 3.28, 95% CI: 2.90–3.70, $P < 0.001$) (Supplemental Digital Content 2, see http://links.lww.com/AOSO/A486). Furthermore, women had a notably increased rates of bowel resection from 1.8% to 2.5% during the pandemic compared with a bowel resection rate of 0.2% in men before and during the pandemic; however, these findings were not shown to be statistically significant (Table 2). When separate multivariable logistic regression analyses were conducted for each gender, women in the pandemic group showed an OR of 1.38 for emergence hernia repair (95% CI: 1.16–1.64, $P < 0.001$), compared with an OR of 1.21 in men in the COVID cohort (95% CI: 1.11–1.32, $P < 0.001$) (Table 3).

Complications Within 30 Days

Postoperative complications are demonstrated in Table 5, where a single patient may have multiple complications per repair. The risk of developing severe complications (Clavien–Dindo grade 3b–5) did not differ between the cohorts (OR: 0.93, 95% CI: 0.79–1.11) (Table 4). In the pre-COVID cohort, 9.8% of the repairs in men (n = 7.119) and 10.2% of repairs in women (n = 859) presented with one or more complications within 30 days, compared with 9.4% and 10.4%, respectively, during the pandemic (Table 5). The majority of complications were classified as Clavien–Dindo grade 1–3a and did not require surgical intervention. Urinary retention was the most frequent complication throughout the study period, affecting 2.2% of men and 1.8% of women, necessitating catheterization. A slight but significant increase in reported early postoperative pain (within 30 days postsurgery) was noticed for both men and women in the pandemic cohort, with an increase of 3.3 percentage points in men and 4.5 percentage points in women (Table 5). Laparo-endoscopic hernia repair was associated with a significant risk reduction of severe postoperative complications (OR: 0.42, 95% CI: 0.33–0.53, $P < 0.001$) (Supplemental Digital Content 1, see http://links.lww.com/AOSO/A486).

The frequency of bowel incarceration increased from 0.6% to 0.8% for men and from 3.3% to 4.8% for women in the pandemic cohort, but these findings were not confirmed statistically significant (Table 2). The 30-day mortality rate in men rose from 0.9% before pandemic to 1.1% during the pandemic, while in women, it rose from 2.2% to 3.8% during the pandemic (Table 5). However, the multivariable regression analyses could not confirm any statistical significance of these shifts (Supplemental Digital Content 4, see http://links.lww.com/AOSO/A486).

Risk of Reoperation

Undergoing groin hernia repair during the COVID pandemic did not increase the risk of reoperation for a recurrence (OR: 0.73, 95% CI: 0.64–0.82, $P < 0.001$) (Table 4). The recurrence rate declined by 1.3% for men and 0.8% for women in the pandemic group (Table 2), and the multivariable logistic analysis for respective sexes confirmed these findings (Table 3). Significant risk factors of reoperation for recurrence were the presence of early postoperative complications, emergency repair, finding of medial or femoral hernia, or if undergoing secondary repair (Supplemental Digital Content 3, see http://links.lww.com/AOSO/A486).

DISCUSSION

This large-scale nationwide cohort study demonstrates a marked decrease by 22.9% in the total number of groin hernia repairs during the COVID pandemic, with the most significant reduction occurring in the first 3 to 4 months in 2020. Consequently, the average waiting time for surgery increased. Despite the significant reduced volume of elective repairs during the COVID pandemic, our study did not find a substantial increase in the risks of mortality or severe complications on a national level, contrary to initial concerns.[10] However, multivariable logistic regression analyses revealed an increased risk of emergency repairs due to postponement of elective surgeries, along with a significant reduction in reoperation rates for recurrence during the COVID pandemic. These findings were consistent both on a national scale and when comparing men and women separately. Specifically, the female population had notably higher crude rates of emergency repair, 30-day mortality, and severe adverse events postoperatively during the pandemic than prior, but also in comparison to men.

Emergency Repair

In SHR, emergency hernia repair is defined as any hernia operated within 24 hours of emergency admittance to the hospital. Hence, an emergency hernia according to this definition could be reduced and operated subacute within 24 hours of admittance. Although the total number of acute hernia repairs declined in 2020, we observed a subsequent increase later in 2021 and early 2022, probably a rebound effect (Fig. 1B). From our data, we cannot predict whether this initial decline in the number of emergency hernia repairs is attributed to postponement of elective surgeries in early 2020 or if present patients with incarcerated but reduceable hernias were discharged for later repairs instead of being operated subacutely during the same admission.

It is well established that acute groin hernia repair is associated with increased risks of mortality and morbidity, particularly in women with femoral hernias who face a sevenfold higher postoperative mortality risk and nearly a 20-fold higher risk if bowel resection is required, as reported by Nilsson et al.[13] In the present study, women were up to 3 times more likely to present with an emergency hernia repair compared with men in both cohorts. Female gender as an unfavorable influencer on the mortality rates and risk of emergency repairs has also been observed in earlier register studies.[13–15] The higher rates of bowel resection and cardiopulmonary complications seen in women compared with men in this study could be attributed to higher comorbidities (ASA scores >3) among women in the COVID cohort, likewise the higher prevalence of femoral hernias in

women.[13,16,17] The overall frequency and pattern of remaining postoperative complications within 30 days showed similarity for both men and women across these cohorts, with most of the patients experiencing only minor complications that required no intervention (Clavien–Dindo grade <3a) and consistent with the reported complication rates in the literature.[18] However, an increased proportion of early postoperative pain was observed in the COVID cohort for both men and women, even though the proportion was slightly higher in the latter group, reflecting the predicted higher risk of postoperative pain in women.[19]

Recently, Jong et al[20] reported a significant increase in the number of emergency hernia repairs during the COVID-19 pandemic; however, their material also included ventral and incisional hernias apart from groin hernias, and with data from only 4 regional hospitals. On the contrary, our large-scale data indicate that decreasing the volume of elective groin hernia repairs does not appear to increase the incidence of emergency repairs in the entire population, at least not in the short term, which aligns with the findings by Dahlstrand et al.[14] They reported that more than 50% of patients undergoing emergency femoral hernia surgery had no symptoms before the emergency operation and concluded that it is not possible to reduce emergency hernia surgeries by operating on an increasing share of elective hernias.

Impact of the COVID-19 Pandemic

Groin hernia repairs performed under local anesthesia increased initially during the pandemic in both cohorts, despite prior concerns that local anesthesia could potentially increase the risk of recurrence and postoperative complications.[16,18] Early recommendations from Ireland, indicating that laparoscopic surgery during the pandemic posed a separate risk, in combination with the shortage of anesthetics during the initial pandemic phase, have most likely contributed to this shift.[21] However, these recommendations were quickly withdrawn due to insufficient evidence, and instead, the operating room personnel were mandated to use personal protective equipment for all surgical procedures, regardless of the patient's COVID-19 status.[21,22]

The proportion of laparo-endoscopic repairs remained relatively unchanged during the pandemic, likely due to continued operations in private hospitals that mainly managed healthy and low-risk patients (ASA score I–II) on referral from public healthcare. Consequently, patients with higher comorbidity or incarcerated and strangulated hernias were primarily treated with open hernia repair in public healthcare, partially explaining the observed risk reduction in severe complications with the laparo-endoscopic approach in this study (Supplemental Digital Content 1, see http://links.lww.com/AOSO/A486).

We also observed a reduced number of active smokers undergoing inguinal hernia repair during the pandemic, likely due to an initial negative selection process in which patients with severe comorbidities were advised to isolate.[23] This reduction could also reflect the decreased smoking rates in the population.[24]

Recurrence Rates

Among the previously described risk factors for recurrence following groin hernia repair in the literature, the type of admission (elective vs emergency) was not considered a significant risk factor for recurrence in a recent meta-analysis.[16,25–27] However, our findings suggest an increased risk of reoperation for recurrence in both cohorts following emergency groin hernia repair. Additionally, the observed and significant reduction in reoperation risk for recurrence during the pandemic might be attributable to the shorter follow-up time in the latter cohort, as well as reoperations for recurrence were likely deprioritized due to anticipated procedure complexity. Another possible but unmeasurable factor is that most of the hernia repairs during this period were performed by specialists to minimize operating time and conserve anesthesiology resources, while junior surgeons were transferred to work in COVID-19 wards.[2]

Strengths and Limitations

This study benefits from being a nationwide, population-based cohort study with a completeness of 97% and data validation of 98%. Given the large number of unselected groin hernia repairs and with no exclusion bias of surgical expertise or patient's characteristics, the external validity of the study is considered high.

However, the present study has some limitations, and the main one is the variability in restrictions on elective surgeries throughout the pandemic. To account for this, data from both 2020 and 2021 were included in the pandemic cohort, as infection rates surged in Autumn 2021, prompting renewed restrictions. However, elective hernia surgeries resumed during most of 2021 in Sweden, potentially diminishing the observed impact of the pandemic on our results. Another limitation is that we are only studying the risk of reoperation for recurrence and hence not the actual recurrence rate. Additional follow-up time is needed to assess the long-term risk of reoperation for recurrence. Based on our material, we can only conclude that the crude reoperation rate was higher before the pandemic, assumingly due to shorter follow-up time for the pandemic group. Finally, unfortunately it is not possible to distinguish the patients with incarcerated or strangulated groin hernias that could be reduced and repaired at a later stage when underlying surgery within 24 hours was avoided, from those who had elective repairs without prior incarceration or strangulation, which might have had an unadjusted effect on our observations.

CONCLUSIONS

Postponing elective groin hernia repairs on a national scale is both feasible and safe when healthcare resources require temporary reallocation. Despite a significant reduction in the number of elective groin hernia repairs in the population, the overall rates of acute hernia repairs across Sweden, along with mortality and severe complication rates, remained consistent throughout the study period, particularly among men. In contrary to our initial hypothesis, our findings indicate that watchful waiting for symptomatic groin hernias in men appears to be safe in terms of mortality, morbidity, and emergency repair risks. While elective repairs can temporally be deferred during healthcare crises, careful consideration should be given to women. Our data confirmed that female sex was associated with an increased risk of emergency repair and accompanied by higher crude numbers of 30-day mortality rates and bowel resection compared with men. Given the large sample size of this study, watchful waiting may not be an appropriate recommendation for women in future pandemics or similar situations requiring resource reallocation, warranting further investigations.

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REFERENCES

1. WHO COVID-19 dashboard. World Health Organization; 2023. Available at: https://covid19.who.int. Accessed January 6, 2024.
2. Sandblom G, Österberg J, Rogmark P, et al. Impact of the COVID-19 pandemic on the management of gallstone surgery: a Swedish population-based study. *Scand J Surg*. 2022;111:14574969211070389.
3. Vårdgarantin. Socialstyrelsens plan för arbetet med tillgänglighet och vårdkapacitet. Socialstyrelsen; 2024. Available at: https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/2024-11-9312.pdf. Accessed January 6, 2024.
4. Axman E, Nordin P, Modin M, et al. Assessing the validity and cover rate of the national Swedish Hernia Register. *Clin Epidemiol*. 2021;13:1129–1134.
5. Fitzgibbons RJ Jr, Giobbie-Hurder A, Gibbs JO, et al. Watchful waiting vs repair of inguinal hernia in minimally symptomatic men: a randomized clinical trial. *JAMA*. 2006;295:285–292.
6. Van den Dop LM, Van Egmond S, Heijne J, et al; INCA Trialists' Collaboration. Twelve-year outcomes of watchful waiting versus surgery of mildly symptomatic or asymptomatic inguinal hernia in men aged 50 years and older: a randomised controlled trial. *EClinicalMedicine*. 2023;64:102207.
7. Schroeder AD, Tubre DJ, Fitzgibbons RJ. Watchful waiting for inguinal hernia. *Adv Surg*. 2019;53:293–303.
8. Ramanan B, Maloley BJ, Fitzgibbons RJ. Inguinal hernia: follow or repair? *Adv Surg*. 2014;48:1–11.
9. STROBE Checklist. STROBE Statement—checklist of items that should be included in reports of observational studies. Available at: https://www.strobe-statement.org/checklists/. Accessed January 6, 2024.
10. Swedish Hernia Register. Annual National Report. 2022. https://prestatistik.incanet.se/svensktbrackregister/. Accessed September 9, 2023.
11. Dindo D, Demartines N, Clavien P-A. Clavien Dindo classification. *Ann Surg*. 2004;240:205–213.
12. ASA Classification. Statement on ASA (American Society of Anesthesiologists) Physical Status Classification System. Available at: https://www.asahq.org/standards-and-practice-parameters/statement-on-asa-physical-status-classification-system. Accessed January 6, 2024.
13. Nilsson H, Stylianidis G, Haapamäki M, et al. Mortality after groin hernia surgery. *Ann Surg*. 2007;245:656–660.
14. Dahlstrand U, Melkemichel M, Österberg J, et al. Female groin hernia repairs in the Swedish Hernia Register 1992-2022: a review with updates. *J Abdom Wall Surg*. 2023;2:11759.
15. Köckerling F, Heine T, Adolf D, et al. Trends in emergent groin hernia repair-an analysis from the Herniamed Registry. *Front Surg*. 2021;8:655755.
16. HerniaSurge Group. International guidelines for groin hernia management. *Hernia*. 2018;22:1–165.
17. Stabilini C, van Veenendaal N, Aasvang E, et al. Update of the international HerniaSurge guidelines for groin hernia management. *BJS Open*. 2023;7:zrad080.
18. Dirk W. Risk factors for perioperative complications in inguinal hernia repair – a systematic review. *Innov Surg Sci*. 2017;2:47–52.
19. Lundström KJ, Holmberg H, Montgomery A, et al. Patient-reported rates of chronic pain and recurrence after groin hernia repair. *Br J Surg*. 2018;105:106–112.
20. Jong DLC, Vries Reilingh TS, Hoek PEN, et al. Significant increase of emergency hernia operation during COVID. *Hernia*. 2024;28:1855–1859.
21. Royal College of Surgeons of England and Ireland. Intercollegiate general surgery guidance on COVID-19. 2020. Available at: https://www.rcsed.ac.uk/news-public-affairs/news/2020/march/intercollegiate-general-surgery-guidance-on-covid-2019-update. Accessed September 9, 2023.
22. Francis N, Dort J, Cho E, et al. SAGES and EAES recommendations for minimally invasive surgery during COVID-19 pandemic. *Surg Endosc*. 2020;34:2327–2331.
23. Public Health Agency of Sweden. 2020. Available at: https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/. Accessed January 6, 2024.
24. Almeda N, Gómez-Gómez I. The impact of the COVID-19 pandemic on smoking consumption: a systematic review of longitudinal studies. *Front Psychiatry*. 2022;13:941575.
25. Burcharth J, Pommergaard HC, Bisgaard T, et al. Patient-related risk factors for recurrence after inguinal hernia repair: a systematic review and meta-analysis of observational studies. *Surg Innov*. 2015;22:303–317.
26. Eklund AS, Montgomery AK, Rasmussen IC, et al. Low recurrence rate after laparoscopic (TEP) and open (Lichtenstein) inguinal hernia repair: a randomized, multicenter trial with 5-year follow-up. *Ann Surg*. 2009;249:33–38.
27. Haladu N, Alabi A, Brazzelli M, et al. Open versus laparoscopic repair of inguinal hernia: an overview of systematic reviews of randomised controlled trials. *Surg Endosc*. 2022;36:4685–4700.