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Profile of pediatric surgical activity at a referral hospital in Boyacá, Colombia, and the impact of the COVID-19 pandemic: a retrospective study of 3,444 procedures (2016–2021)

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Abstract

Purpose.

To describe the profile of pediatric surgical activity at a fourth-level referral hospital in Boyacá, Colombia, and to assess whether the COVID-19 pandemic altered its volume and case-mix.

Methods.

Retrospective observational study (STROBE) of all 3,444 procedures performed in patients under 18 years between January 2016 and December 2021. Recorded diagnoses were assigned to mutually exclusive clinical categories. The pandemic period was defined from March 1, 2020. Proportions between periods were compared with the χ^2 test and monthly volumes with the Mann-Whitney U test; category-level volume comparisons were exploratory and unadjusted for multiplicity.

Results.

Most patients were male (59.67%) and of school age (32.90%); 65.30% of procedures were emergencies. Appendicitis and its complications were the leading indication (1,524; 44.25%), followed by abdominal wall and inguinoscrotal conditions (606; 17.60%) and soft-tissue masses (192; 5.57%). Total monthly volume was unchanged during the pandemic (48.20 versus 47.00 per month; $p = 0.932$), but its composition shifted: emergency procedures rose from 63.61% to 69.25% ($\chi^2=9.90$, $df = 1$, $p = 0.002$), the case-mix distribution changed ($\chi^2=67.53$, $df = 16$, $p < 0.001$), and the age distribution shifted toward adolescents ($\chi^2=60.24$, $df = 4$, $p < 0.001$). Of sixteen categories, three changed nominally significantly in volume: congenital and craniofacial defects (− 61.32%; $p = 0.030$), airway procedures (− 58.46%; $p = 0.017$), and appendicitis (+ 21.88%; $p = 0.009$). No laparoscopic inguinal hernia repair was recorded.

Conclusion.

Overall pediatric surgical volume was preserved, but the pandemic significantly redistributed it from elective toward emergency activity and toward older children, in a Latin American middle-income setting.

Introduction

Access to timely surgical care remains deeply unequal worldwide. The Lancet Commission on Global Surgery estimated that five billion people lack access to safe, affordable surgical care when needed, and framed surgery as an indivisible part of universal health coverage rather than a luxury of high-income systems [1]. Children carry a large share of this gap. Modelling based on national surgical capacity estimated that roughly 1.7 billion children and adolescents lacked access to surgical care in 2017, with

the shortfall concentrated in low-income and lower-middle-income countries where fewer than one in twelve children can reach a provider when a surgical need arises [2].

Two coordinated responses have shaped the field. The Global Initiative for Children's Surgery brought together providers from every region to define what children's surgical systems require, organized around infrastructure, service delivery, training, and research [3]. From that work came the Optimal Resources for Children's Surgical Care document, which specifies the personnel, equipment, and organizational standards appropriate to each level of care and gives planners a concrete benchmark against which to measure a service [4]. Applying such benchmarks depends on locally generated data, yet published descriptions of the actual profile of pediatric surgical activity in Latin America are scarce, and none exists for the department of Boyacá or for central-eastern Colombia.

The COVID-19 pandemic then imposed an abrupt stress test on surgical systems everywhere. Predictive modelling by the CovidSurg Collaborative projected the cancellation or postponement of more than 28 million elective operations during the first twelve weeks of peak disruption, the overwhelming majority for benign disease [5]. Subsequent syntheses documented delays in emergency presentations across many conditions, including appendicitis, during the same period [6]. How these forces reshaped the overall composition of pediatric surgery, rather than any single condition, in a Latin American referral hospital has not been described.

This study describes the case-mix, demographic profile, and temporal trends of pediatric surgical activity at the referral hospital for the department of Boyacá over six consecutive years, and examines whether the pandemic altered its volume and composition. Two conditions that dominate this activity, acute appendicitis and abdominal wall or groin hernias, are the subject of dedicated companion analyses now in the process of publication. The present study addresses the aggregate profile and refers to those works rather than repeating their internal analyses.

Materials and methods

Design, setting and participants

This was a descriptive, observational, retrospective study, reported in accordance with the STROBE guideline for observational research [7]. All surgical procedures performed by the pediatric surgery service of the Hospital Universitario San Rafael de Tunja, a fourth-level referral center for Boyacá and central-eastern Colombia, in patients under 18 years of age between January 1, 2016, and December 31, 2021, were included. No procedure was excluded. Data were obtained from the surgical procedure records and complemented with the clinical chart. Records were anonymized before analysis, and no patient identifiers were used at any stage.

Variables and category assignment

The following variables were recorded: age group, sex, surgical priority (elective versus emergency), operative timing (daytime versus night), and the primary diagnosis. Age was classified into the standard pediatric groups (neonate, infant, preschool, school age, adolescent).

The institutional register records the diagnosis as free text rather than as a coded classification, and 130 distinct diagnostic labels were present. Two authors assigned each label to a single mutually exclusive category defined a priori by anatomical region or pathogenesis, and disagreements were resolved by consensus with the attending pediatric surgeon. Sixteen clinical categories plus a residual category were defined, and every one of the 3,444 procedures was assigned to exactly one of them. Three grouping decisions warrant explicit statement because they affect interpretation. First, inguinal and umbilical hernia, cryptorchidism and hydrocele were grouped together as abdominal wall and inguinoscrotal, reflecting their shared origin in the processus vaginalis and their overlapping operative management. Second, foreign body ingestion was analyzed separately from trauma, because although both are unintentional injuries their mechanism and management differ. Third, functional and acquired digestive conditions such as gastroesophageal reflux, swallowing disorder, achalasia and faecal incontinence were separated from structural congenital malformations, so that the malformation category contains only structural anomalies. The full mapping of diagnostic labels to categories is available from the corresponding author.

Statistical analysis

Categorical variables are reported as absolute frequencies and percentages, and monthly volumes as means. The pandemic period was defined from March 1, 2020, because the mandatory national lockdown in Colombia began on March 24, 2020; the pre-pandemic period therefore comprises 50 months and the pandemic period 22 months.

Two complementary approaches were used. Differences in the distribution of categorical variables between the two periods, namely sex, surgical priority, operative timing, age group and the overall case-mix, were assessed with the Pearson χ^2 test of independence, reported as χ^2 with its degrees of freedom (df) and p value; the minimum expected cell count was above five in every contingency table, so no exact alternative was required. Differences in surgical volume were assessed on monthly counts, which were not normally distributed, using the Mann-Whitney U test. The two approaches answer different questions: the χ^2 test asks whether the composition of activity changed, whereas the Mann-Whitney test asks whether its absolute monthly volume changed.

The comparison of total monthly volume and the χ^2 comparisons of composition were the prespecified primary analyses. The sixteen category-level volume comparisons are exploratory and hypothesis-generating: they were not prespecified, no correction for multiple comparisons was applied, and p values are reported descriptively rather than as confirmatory tests. Under a Bonferroni threshold none of the category-level differences would remain significant, so these results should be read as signals warranting confirmation in larger or multicenter series rather than as established effects. A two-sided p

value below 0.05 is reported as nominally significant. Analyses were performed in Python (pandas and SciPy). The authors used an artificial intelligence tool to support data analysis, bibliographic verification, and language editing, and reviewed and validated all content.

Results

Demographic profile and case-mix

A total of 3,444 procedures were analyzed. Boys accounted for 59.67% of patients and girls for 40.33%. School-age children were the largest group (32.90%), followed by adolescents (27.03%), preschool children (19.54%), infants (15.74%), and neonates (4.79%). Most procedures were performed as emergencies (65.30%) and during daytime hours (76.71%). Appendicitis and its complications formed the single largest category, accounting for close to half of all activity; together with abdominal wall and inguinoscrotal conditions the two leading categories represented 61.85% of the workload. The residual category, comprising records with no registered diagnosis or with a non-surgical label, accounted for 0.58% (Table 1).

Table 1
Demographic profile and surgical case-mix, 3,444 procedures, 2016–2021.

Variable	n	%
Sex		
Male	2,055	59.67
Female	1,389	40.33
Age group		
Neonate	165	4.79
Infant	542	15.74
Preschool	673	19.54
School age	1,133	32.90
Adolescent	931	27.03
Surgical priority		
Emergency	2,249	65.30
Elective	1,195	34.70
Operative timing		
Daytime	2,642	76.71
Night	802	23.29
Surgical category		
Appendicitis and complications	1,524	44.25
Abdominal wall and inguinoscrotal	606	17.60
Soft-tissue masses	192	5.57
Bowel obstruction and acute abdomen	170	4.94
Difficult vascular access	170	4.94
Digestive malformations	160	4.65
Genitourinary	120	3.48
Airway	110	3.19
Thoracic and pleuropulmonary	81	2.35
Functional digestive disorders	68	1.97

Variable	n	%
Sex		
Congenital and craniofacial defects	55	1.60
Hepatobiliary and other digestive	48	1.39
Trauma	48	1.39
Gynecologic and breast	35	1.02
Foreign body ingestion	20	0.58
Other or not registered	20	0.58
Tumoral lesions	17	0.49

 Inguinal, umbilical, epigastric and incisional hernia, congenital abdominal wall defects, cryptorchidism, hydrocele and related groin conditions.

 Structural congenital anomalies only: anorectal malformation, oesophageal and intestinal atresia, Hirschsprung disease, Meckel diverticulum, malrotation, hypertrophic pyloric stenosis, biliary atresia, choledochal cyst, intestinal duplication, meconium ileus.

 Gastro-oesophageal reflux, swallowing disorder, achalasia, faecal incontinence, dysfunctional gastrostomy.

 Thyroglossal and branchial cysts, branchial remnant fistula, preauricular appendage, ankyloglossia, polydactyly.

 Solid and cystic neoplasms of any site, including intra-abdominal, mediastinal, testicular, pancreatic and thyroid lesions.

Changes in patient and procedure profile between periods

The composition of surgical activity changed significantly between the two periods, even though the total volume did not (Table 2). The proportion of procedures performed as emergencies rose from 63.61% to 69.25% (χ^2=9.90, df = 1, p = 0.002), confirming a shift away from scheduled activity. The age distribution also changed (χ^2=60.24, df = 4, p < 0.001): adolescents rose from 23.73% to 34.72% of the caseload while infants fell from 17.80% to 10.93% and neonates from 5.15% to 3.97%. The overall distribution across the seventeen surgical categories differed significantly between periods (χ^2=67.53, df = 16, p < 0.001), with appendicitis rising from 41.16% to 51.45% of all activity. By contrast, the sex distribution (χ^2=0.00, df = 1, p = 0.971) and the proportion of procedures performed during daytime hours (χ^2=0.82, df = 1, p = 0.366) were unchanged.

Table 2
Distribution of patient and procedure characteristics before and during the pandemic.

Variable	Pre-pandemic n (%)	Pandemic n (%)	χ^2	df	p
Sex			0.00	1	0.971
Male	1,439 (59.71)	616 (59.57)			
Female	971 (40.29)	418 (40.43)			
Surgical priority			9.90	1	0.002
Emergency	1,533 (63.61)	716 (69.25)			
Elective	877 (36.39)	318 (30.75)			
Operative timing			0.82	1	0.366
Daytime	1,838 (76.27)	804 (77.76)			
Night	572 (23.73)	230 (22.24)			
Age group			60.24	4	< 0.001
Neonate	124 (5.15)	41 (3.97)			
Infant	429 (17.80)	113 (10.93)			
Preschool	495 (20.54)	178 (17.21)			
School age	790 (32.78)	343 (33.17)			
Adolescent	572 (23.73)	359 (34.72)			
Case-mix (17 categories) □	2,410 (100)	1,034 (100)	67.53	16	< 0.001

□ Full category distribution given in Table 1 for the whole cohort and in Table 3 by period. Appendicitis represented 41.16% of pre-pandemic and 51.45% of pandemic activity.

Surgical volume during the pandemic

Total monthly surgical volume was essentially unchanged between the two periods, at 48.20 procedures per month before the pandemic and 47.00 during it (Mann-Whitney U; p = 0.932) (Fig. 1a). The annual counts were 614 (2016), 494 (2017), 586 (2018), 620 (2019), 490 (2020), and 640 (2021), so the reduction in 2020 was fully recovered in 2021, the highest count of the series.

Behind this stable total, activity was redistributed. Elective surgery fell from 17.54 to 14.45 procedures per month, a reduction of 17.59%, whereas emergency surgery rose from 30.66 to 32.55 per month, an increase of 6.15% (Fig. 1b). Taken as monthly volumes neither difference reached significance on its own (p = 0.186 and p = 0.163 respectively), reflecting the wide month-to-month variability of the series;

the same shift expressed as a change in composition was significant (χ^2=9.90, df = 1, p = 0.002; Table 2). The redistribution of a preserved total from elective toward emergency activity is the central finding of this analysis.

Exploratory change by surgical category

The magnitude and direction of change varied across categories (Table 3, Fig. 2). Three of sixteen categories reached nominal significance: congenital and craniofacial defects fell by 61.32% (p = 0.030), airway procedures by 58.46% (p = 0.017), and appendicitis rose by 21.88% (p = 0.009). Difficult vascular access fell by 34.57% (p = 0.055) and gynecologic and breast procedures rose by 114.65% (p = 0.088), both short of the threshold. Trauma rose by 109.09% and foreign body ingestion by 85.95%, but neither approached significance (p = 0.276 and p = 0.147), reflecting the small monthly counts in these categories. All remaining categories declined between 6% and 40% without statistical support. As set out in the Methods, these sixteen comparisons are exploratory and unadjusted, and none would survive correction for multiplicity.

Table 3
Exploratory change in mean monthly volume by surgical category, pandemic versus pre-pandemic period.

Category	n	Pre-pandemic	Pandemic	Change (%)	p †
Congenital and craniofacial defects	55	0.94	0.36	−61.32	0.030
Airway	110	1.86	0.77	−58.46	0.017
Thoracic and pleuropulmonary	81	1.28	0.77	−39.63	0.130
Difficult vascular access	170	2.64	1.73	−34.57	0.055
Tumoral lesions	17	0.26	0.18	−30.07	0.887
Digestive malformations	160	2.40	1.82	−24.24	0.273
Soft-tissue masses	192	2.86	2.23	−22.12	0.184
Bowel obstruction and acute abdomen	170	2.48	2.09	−15.69	0.713
Abdominal wall and inguinoscrotal	606	8.82	7.50	−14.97	0.327
Genitourinary	120	1.74	1.50	−13.79	0.510
Functional digestive disorders	68	0.98	0.86	−11.87	0.610
Hepatobiliary and other digestive	48	0.68	0.64	−6.42	0.863
Appendicitis and complications	1,524	19.84	24.18	+ 21.88	0.009
Foreign body ingestion	20	0.22	0.41	+ 85.95	0.147
Trauma	48	0.50	1.05	+ 109.09	0.276
Gynecologic and breast	35	0.36	0.77	+ 114.65	0.088

† Mann-Whitney U test on monthly counts. Exploratory analysis without adjustment for multiple comparisons; p values are descriptive.

Appendicitis and operative approach

Appendicitis was the only high-volume category to increase during the pandemic, from 19.84 to 24.18 procedures per month (+ 21.88%; p = 0.009). Within this category, the proportion of records coded as complications related to appendicitis was similar in both periods (48 of 992, 4.84%, before the pandemic; 27 of 532, 5.08%, during it), so the increase reflected a higher volume of appendicitis rather than a shift toward more severe disease as captured by this coding. Because this label is administrative rather than an operative or histological classification, the severity of appendicitis is examined with a dedicated definition in the companion analysis.

No laparoscopic inguinal hernia repair was recorded during the six years, and minimally invasive approaches were confined to appendectomy and a small number of other procedures. This absence, in a fourth-level referral center performing 606 abdominal wall and groin procedures over the period, points to a gap in equipment and training rather than to case selection.

Discussion

This six-year series is, to our knowledge, the first description of the profile of pediatric surgical activity in the department of Boyacá. Two features stand out: a case-mix dominated by acute conditions, and a pandemic that preserved total volume while redistributing activity from elective toward emergency surgery.

The dominance of acute appendicitis, which accounted for close to half of all procedures, together with an emergency proportion of 65.30%, indicates that this referral center functions largely as a provider of urgent and non-deferrable pediatric surgery. This pattern is characteristic of referral hospitals in middle-income settings, where elective and highly specialized activity is comparatively limited and acute presentations predominate, and where the resources described in the OReCS framework are unevenly available [4]. The scarcity of published Latin American case-mix data makes such descriptions valuable for regional planning and international comparison, and gives local meaning to the access gap quantified at the global level [1, 2].

The pandemic did not reduce total surgical volume in our institution, a finding that departs from the large reductions modelled globally for elective adult surgery [5] but is consistent with the observation that pediatric surgical demand is driven substantially by emergencies that cannot be postponed. What changed was the composition of activity: the share of emergency procedures rose significantly ($\chi^2=9.90$, df = 1, $p = 0.002$) and the distribution across surgical categories differed between periods ($\chi^2=67.53$, df = 16, $p < 0.001$), while the total remained flat. This dissociation between a stable volume and an altered composition is worth emphasising, because a service audit reporting only case numbers would have concluded that nothing happened. It also explains why the monthly volume comparisons of elective and emergency activity were individually non-significant while the compositional test was not: with 72 monthly observations and wide seasonal variability, volume tests are insensitive to a shift that the proportional analysis detects clearly. The pattern mirrors at the level of a single center the elective-to-emergency shift described in large collaborative datasets [5, 6]. The recovery of total volume in 2021 to the highest count of the series suggests a resilient service that absorbed the shock and cleared the accumulated elective backlog once restrictions eased, in line with the workforce and capacity dynamics examined by the CovidSurg Collaborative [17].

The age distribution shifted markedly toward older children, with adolescents rising from 23.73% to 34.72% of the caseload and infants falling from 17.80% to 10.93% ($\chi^2=60.24$, df = 4, $p < 0.001$). This is the demographic signature of the same redistribution rather than an independent phenomenon: appendicitis, which rose during the pandemic, is predominantly a disease of school-age children and adolescents,

whereas the categories that contracted most, including congenital and craniofacial defects, hernia repair and difficult vascular access, are concentrated in infants and neonates. The corollary is that the youngest patients, whose conditions are largely congenital and scheduled, bore the greater share of deferred care.

The two largest declines were in congenital and craniofacial defects and in airway procedures, and both are interpretable. Craniofacial and congenital lesions such as thyroglossal and branchial cysts, preauricular appendages and ankyloglossia are almost entirely elective and can be deferred without immediate risk, so they were among the first to be suspended and among the last to be rescheduled. Airway procedures have a different explanation. Non-pharmaceutical interventions during the pandemic sharply reduced the circulation of seasonal respiratory viruses, with influenza and respiratory syncytial virus falling to a small fraction of their pre-pandemic activity in population surveillance [13, 14]. A lower burden of respiratory infection plausibly reduced the demand for bronchoscopy, foreign-body retrieval and related airway interventions, so this decline probably reflects a genuine fall in incidence rather than deferral alone.

Trauma more than doubled during the pandemic, and foreign body ingestion rose by 86%, both consistent with the expectation that prolonged confinement shifts childhood injury from public and school settings into the home. We report these changes descriptively and do not claim an effect, because neither approached statistical significance and both rest on fewer than one additional case per month. Separating foreign body ingestion from trauma, which we did on clinical grounds, removed the apparent statistical support that the combined category had shown, and we consider the more conservative reading the correct one.

The behavior of appendicitis merits careful framing. Appendicitis volume rose significantly during the pandemic while the proportion coded as complicated remained essentially unchanged. This differs from a nationwide multicenter analysis in which pediatric appendicitis presentations fell by roughly a third early in the pandemic [11], and it does not reproduce the increase in complicated or perforated appendicitis reported by several syntheses, which found a relative risk of complicated disease of 1.63 [8], a rise in perforation from 28.5% to 39.4% [9], and an increase from 20.7% to 27.8% in a multicenter study [10]. Two cautions apply. First, our marker of severity is an administrative coding label rather than an operative or histological classification, so it may underestimate true perforation. Second, the proportion of complicated disease is itself a problematic quality indicator, because much of the natural history of appendicitis, including spontaneous resolution and prehospital perforation, is not modifiable by the timing of care [12]. Reporting the absolute monthly volume alongside the coded proportion, as we do, guards against the selection artefact that a proportion alone can introduce.

The complete absence of laparoscopic inguinal hernia repair over six years, in a center that performed 606 abdominal wall and groin procedures, is a concrete marker of the technology and training gap that separates many middle-income referral hospitals from the current standard. Randomized and pooled evidence supports laparoscopic repair in children, with a lower risk of ascending testis and

metachronous contralateral hernia in boys [15] and fewer major complications in the specific setting of incarceration [16]. The gap we document is actionable, and closing it is a defined target within the OReCS benchmarks [4].

Finally, the structure of the source register is itself a finding. Diagnoses were recorded as free text with 130 distinct labels, some of them duplicates of the same entity under different names, some recording a ruled-out or non-surgical condition, and twenty records carrying no usable diagnosis. Constructing an analysable case-mix required manual mapping rather than extraction of a coded field. This reflects the state of clinical information systems in a public referral hospital of a middle-income country and constrains the research and planning such systems can support. Adopting a coded diagnostic classification is a low-cost intervention with a high return for both care and research.

Limitations and strengths

This is a retrospective, single-center study based in part on manual records, with the incompleteness and occasional illegibility that such sources carry. Surgical categories were constructed by the investigators from free-text diagnoses rather than taken from an external standardized classification, so some misclassification is possible and the grouping decisions, although stated explicitly, involve judgement. The marker of appendicitis severity is a coding label rather than an operative finding. The category-level comparisons are exploratory and unadjusted, and several categories contain fewer than one procedure per month, which leaves them underpowered; the doubling of trauma illustrates how a large percentage change can rest on very few cases. Variables including time from symptom onset to consultation, length of stay, and histopathological confirmation could not be recovered. The χ^2 comparisons describe changes in composition and cannot by themselves establish a change in underlying incidence, since a rise in one category's share can result from a fall in others. As strengths, the sample is large and complete for the period with no exclusions, the six-year span places the pandemic within its wider temporal context, every procedure is assigned to exactly one category so that percentages sum to the whole cohort, and the analysis reports absolute monthly volumes with the statistical status of each comparison stated explicitly.

Conclusion

Overall pediatric surgical volume at this Colombian referral center was preserved through the pandemic, but activity was significantly redistributed from elective toward emergency and non-deferrable surgery ($\chi^2=9.90$, $p = 0.002$) and toward older children ($\chi^2=60.24$, $p < 0.001$). The clearest declines were in congenital and craniofacial defects and in airway procedures, and appendicitis was the only high-volume category to increase, without a change in coded severity. These data help characterize pediatric surgical care in a Latin American middle-income setting and identify concrete targets, from laparoscopic capacity to coded diagnostic recording, for strengthening the service.

Declarations

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Competing interests. The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval. This retrospective study involving human participants was performed in line with the principles of the Declaration of Helsinki and Resolution 008430 of 1993 of the Colombian Ministry of Health. The data were collected within the approved research project (Pediatric surgical pathology at a fourth-level university hospital in central-eastern Colombia, Tunja, Colombia, between January 2016 and December 2021: pre- and post-pandemic analysis), which was reviewed and approved by the institutional ethics committee of the Hospital Universitario San Rafael de Tunja. Given the retrospective nature of the study and the use of anonymized records, the committee waived the requirement for individual informed consent.

Consent to participate. Not applicable; the study used anonymized retrospective records under an ethics committee waiver.

Consent to publish. Not applicable.

Data availability. The datasets generated and analyzed during the current study, including the full mapping of diagnostic labels to analytical categories, are not publicly available because they derive from institutional clinical records, but are available from the corresponding author on reasonable request and subject to institutional approval.

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Figures

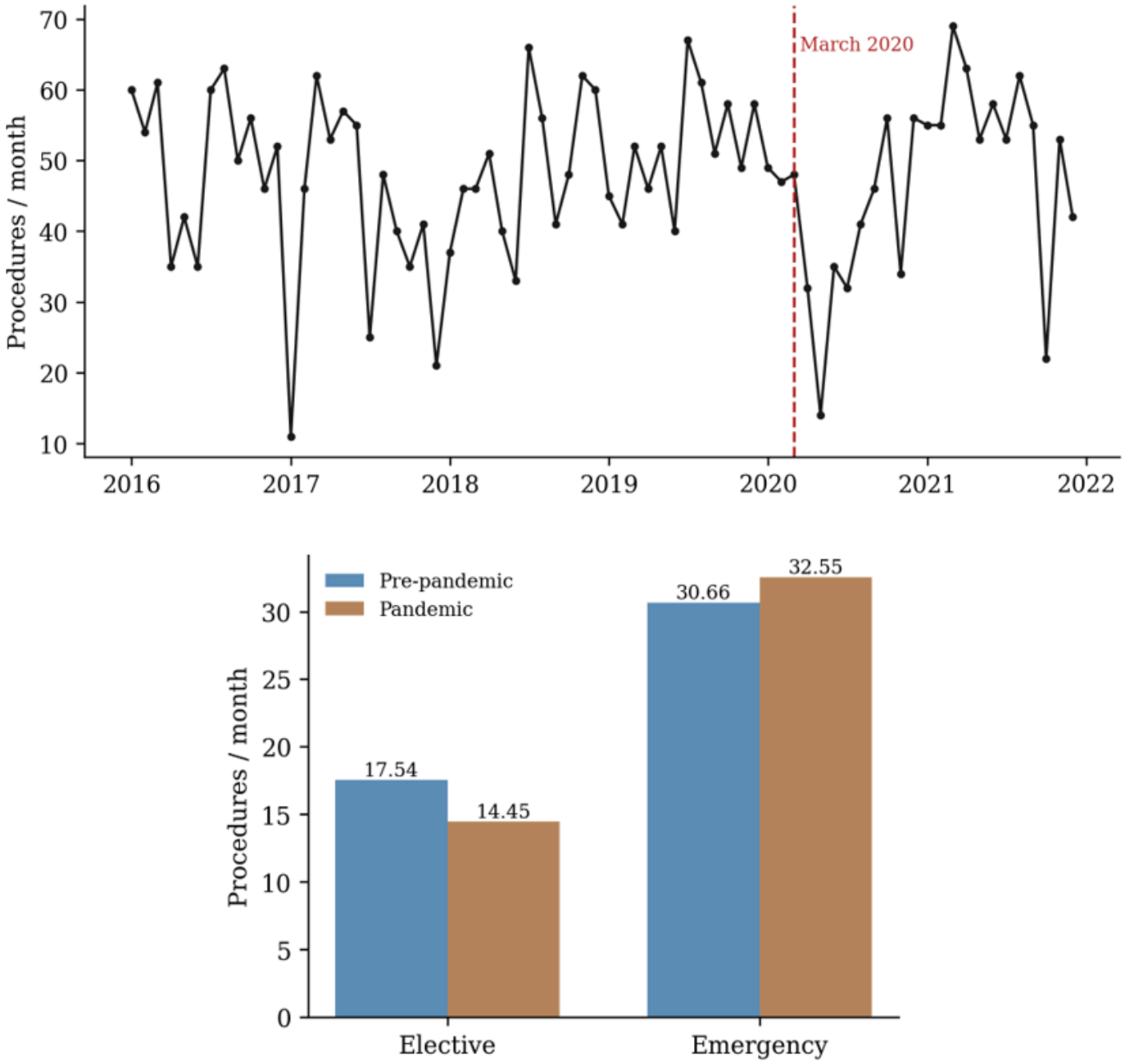


Figure 1

Surgical volume, 2016–2021. a, monthly volume with the March 2020 cutoff. b, mean monthly elective versus emergency volume before and during the pandemic.

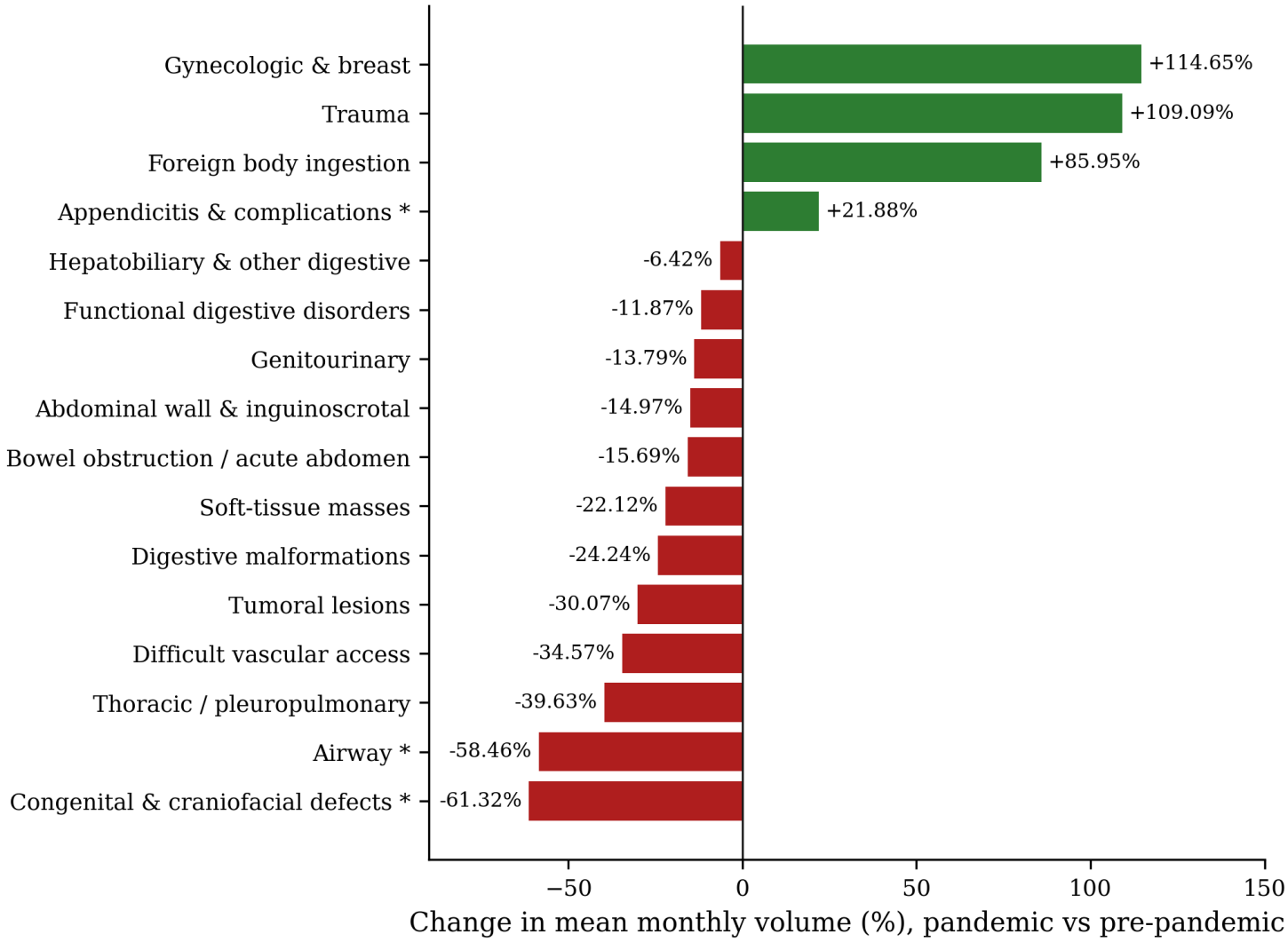


Figure 2

Exploratory change in mean monthly volume by category, pandemic versus pre-pandemic period. Bars to the left of zero indicate a decrease, bars to the right an increase. An asterisk marks categories with a nominal p<0.05, unadjusted for multiple comparisons.