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Neighborhood Disadvantage and Same-Day Surgical Cancellation in Children: A Multispecialty Cohort Study

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Research Article

Keywords: Pediatric surgery, Same-day cancellation, Social Vulnerability Index, Neighborhood disadvantage, Health disparities, Surgical scheduling

Posted Date: September 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10714041/v1

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Additional Declarations: No competing interests reported.

Abstract

Purpose:

Day-of-surgery cancellations (DoSCs) disrupt pediatric surgical care and may disproportionately affect socially disadvantaged groups. We examined associations between neighborhood social vulnerability and DoSC across pediatric surgical specialties.

Methods:

We retrospectively analyzed elective surgical encounters at a freestanding tertiary children's hospital (2020–2025). Geocoded residential addresses were linked to 2020 CDC Social Vulnerability Index (SVI) data. Encounters were classified as completed, non-DoSC, or DoSC. Multivariable logistic regression with cluster-robust standard errors assessed associations of overall SVI and race with DoSC, adjusting for season and year. Documented cancellation reasons were compared across SVI terciles.

Results:

Among 72,489 encounters, 4,066 (5.6%) were DoSCs. Rates increased across SVI terciles from 4.0% to 9.2% ($p < 0.001$). Higher SVI (OR 2.20, 95% CI 1.94–2.49) and Black race (OR 1.89, 95% CI 1.74–2.07) were independently associated with DoSC; the race association persisted after excluding SVI's race theme. Among DoSCs, the proportion attributed to no-shows increased with vulnerability (2.7%–14.1%), whereas clinical reasons declined. Associations remained stable across pandemic and post-pandemic eras.

Conclusion:

Neighborhood social vulnerability and Black race were independently associated with pediatric DoSC across specialties. These findings identify higher-risk encounters and support prospective evaluation of engagement-focused preoperative interventions.

Introduction

Elective surgical cancellations are a common and consequential disruption in pediatric healthcare delivery. Day-of-surgery cancellations (DoSC) affect an estimated 2% to 20% of scheduled procedures in U.S. hospitals, with rates at tertiary pediatric centers often approaching the upper end of this range [1–3]. The consequences of these cancellations extend across stakeholders. For institutions, cancellations represent inefficient use of operating room resources and lost revenue, with operating room time estimated to cost upwards of $36 per minute in the United States [4]. For families, cancellations impose financial costs, logistical disruptions, and emotional distress after the substantial preparation often required for pediatric surgical care. [5] For children, delays in surgical care may carry developmental consequences that are more significant than in adult populations, particularly for time-sensitive procedures [6].

Social determinants of health (SDOH) have emerged as significant contributors to patients experiencing surgical cancellations and disruptions in care. In a multi-center geospatial analysis of pediatric surgical cancellations, Liu and colleagues demonstrated marked geographic variation in DoSC rates, with cancellations clustering in census tracts characterized by socioeconomic disadvantage and higher proportions of racial and ethnic minority residents [1]. Willer and colleagues subsequently found a strong association between lower neighborhood opportunity, measured by the Child Opportunity Index 2.0, and higher DoSC risk at a large tertiary pediatric center with Black children bearing the highest cancellation risk at every level of neighborhood opportunity [7]. Most recently, Santucci and colleagues confirmed these patterns across a multi-site pediatric health system, finding that Black patients and those residing in the lowest neighborhood opportunity quintile experienced disproportionately higher same-day cancellation rates, particularly at an urban tertiary site [8].

Race and neighborhood disadvantage are closely intertwined in the United States, and both have been associated with inequities across the pediatric surgical continuum, from access and clinic attendance to postoperative outcomes [9–12]. In the specific context of surgical cancellation, race and neighborhood opportunity have each been identified as predictors; because the two are correlated, however, whether each contributes independently of the other has been less clear.

Characterizing the neighborhood factors underlying these disparities requires a validated, reproducible area-based measure. The Social Vulnerability Index (SVI), developed by the Centers for Disease Control and Prevention, is a publicly available, nationally standardized index that is linkable to residential address [13–15]. Prior pediatric cancellation studies have relied on the Child Opportunity Index in ambulatory populations and have largely predated or excluded the COVID-19 period. To our knowledge, the SVI has not been applied to day-of-surgery cancellation in a multispecialty pediatric surgical cohort.

Using a large multispecialty cohort of elective pediatric surgical encounters at a freestanding tertiary children's hospital, this study had three aims: to examine the association between neighborhood social vulnerability and DoSC; to evaluate whether race was independently associated with DoSC after adjustment for neighborhood vulnerability; and to determine which dimensions of vulnerability accounted for the association. We further characterized documented cancellation reasons across levels of vulnerability and assessed whether associations were stable across the COVID-19 era. We hypothesized that children from more vulnerable neighborhoods would experience higher DoSC rates and that race would remain independently associated after adjustment for neighborhood disadvantage, reflecting structural factors not fully captured by area-based indices.

Methods

This study was designed as a retrospective cohort analysis performed at a freestanding tertiary pediatric hospital with divisions encompassing surgical specialties, including cardiothoracic surgery, general surgery, neurosurgery, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, and urology. Diagnostic and interventional imaging procedures (for example, magnetic resonance imaging) and other

non-operating-room anesthesia encounters were outside the scope of this surgical cohort and were not included. The protocol was reviewed and approved by the Institutional Review Board (PRO00050562); informed consent was waived, given the retrospective design and use of de-identified data. This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (Online Resource 1). [16]

Surgery encounter records spanning 2020 through 2025 were extracted from the Institutional Data Warehouse. Encounters were stratified by urgency using a calculated days-to-post value, defined as the number of days from the creation of the surgical encounter in the electronic health record to the scheduled operative date. Encounters with a days-to-post of four or fewer days were classified as urgent or emergent per institutional operational definitions, reflecting expedited scheduling outside routine elective pathways, and were excluded from analysis. The analytic cohort was therefore restricted to elective encounters, defined as those with a days-to-post greater than four days.

When a patient had more than one surgical encounter during the study window, each encounter was retained as a separate unit of analysis; within-patient correlation was addressed in the regression models using cluster-robust standard errors. Staged reconstructive procedures and planned revisions were eligible for inclusion provided they satisfied elective criteria. Same-day add-on cases and intraoperative or perioperative conversions from elective to emergent status were excluded from analysis.

Patient and Socioeconomic Variables

Demographic and socioeconomic information for each surgical encounter was obtained from the EHR and institutional administrative databases. Patient-level variables included age at time of encounter, sex (male/female), self-reported race (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White or Caucasian), ethnicity (Hispanic/Latino, Non-Hispanic/Latino, Unknown), and season of the scheduled encounter. Age was derived from the difference between the recorded birth date and encounter date. Season was assigned based on encounter date, with winter encompassing December through February, spring encompassing March through May, summer encompassing June through August, and fall encompassing September through November. Sex recorded as unknown or indeterminate was recoded as missing, as were unknown race or ethnicity and instances of patient refusal to provide this information.

Geocoding and Social Determinant Measures

Residential addresses recorded at the time of the surgical encounter were geocoded using ArcGIS (Esri, Redlands, CA) and linked to the corresponding census tract 2020 CDC/ATSDR Social Vulnerability Index. The SVI summarizes 16 census-derived indicators across four themes: socioeconomic status, household characteristics, racial and ethnic minority status, and housing and transportation. Analyses incorporated the overall composite SVI, the four theme-specific scores, and the individual component

variables as defined in the CDC 2020 documentation. The composite and theme-level scores are expressed as national percentile rankings on a 0 to 1 scale; higher values correspond to greater neighborhood-level social vulnerability.

Patients whose addresses could not be successfully geocoded due to incomplete or invalid data (fewer than 5% of the cohort) were excluded from socioeconomic analyses but retained for descriptive purposes.

Outcome Measures

The primary outcome of interest was DoSC, defined as cancellation of a scheduled surgical case within 24 hours of the planned procedure start time [17, 18]. All encounters were assigned to one of three mutually exclusive categories:

- Completed: Procedure carried out as originally scheduled
- Day-of-Surgery cancellation: Case canceled within 24 hours of the scheduled start time
- Non-Day-of-Surgery cancellation: Case canceled more than 24 hours before the scheduled start time

Statistical Analysis

All non-elective procedures were excluded before analysis. Cohort characteristics were summarized descriptively. Bivariate comparisons between patients whose procedures were cancelled and those whose procedures were completed were performed using Wilcoxon rank-sum tests for continuous variables and Pearson chi-squared tests for categorical variables. Characteristics were further compared across the three mutually exclusive outcome groups (DoSC, non-DoSC, and completed procedure) using Kruskal-Wallis rank-sum tests, Pearson chi-squared tests, and chi-squared tests with simulated p-values where expected cell counts were small. Neighborhood social vulnerability was summarized overall and across terciles of the composite SVI percentile (low, < 0.33; middle, 0.33–0.67; high, ≥ 0.67). Composite SVI was grouped into terciles to define interpretable strata of approximately balanced size for descriptive comparison and for the cancellation-reason analysis; the continuous SVI percentile was retained as the exposure in all regression models.

Day-of-surgery cancellation was modeled using multivariable logistic regression. The primary model compared DoSCs against all other elective encounters (completed procedures and non-DoSCs combined), estimating the association between neighborhood social vulnerability and the occurrence of a DoSC. A secondary model compared DoSCs against non-DoSCs only, restricting the sample to cancelled cases to isolate factors associated with the timing of cancellation rather than its occurrence. Both models included the same covariates, selected a priori based on clinical relevance and prior literature: self-reported race, overall SVI percentile, season of the scheduled encounter, and encounter year. Race was modeled as a categorical predictor with White or Caucasian as the reference category, reflecting its position as the largest group in the cohort. Surgical specialty was examined descriptively

but was not included as a covariate, as it may lie on the causal pathway between social vulnerability and cancellation, where adjustment could introduce overadjustment bias. Associations are reported as odds ratios with 95% confidence intervals, with $p < 0.05$ considered significant.

Because some patients contributed more than one elective encounter during the study window, each encounter was treated as the unit of analysis, and 95% confidence intervals were estimated using cluster-robust (Huber-White sandwich) standard errors clustered on the patient's medical record number, accounting for within-patient correlation.

The composite SVI was correlated with patient race because one of its four constituent themes measures the racial and ethnic minority composition of the census tract. To evaluate whether the independent association between race and DoSC was an artifact of this overlap, we quantified the Pearson correlation between the composite SVI and the racial and ethnic minority theme and fit a sensitivity model that replaced the composite SVI with its three non-race themes (socioeconomic status, household characteristics, and housing and transportation), omitting the racial and ethnic minority theme.

Because the study period spanned the COVID-19 pandemic, cancellation metrics were described by encounter year, and the primary model was repeated separately for 2020 to 2022 and for 2023 to 2025, a division that places the years in which COVID-19 contributed substantially to cancellations in the earlier period.

Several prespecified sensitivity analyses evaluated the robustness of the primary model. To assess whether the association was independent of patient demographics, the model was refit with age and sex added. To address the possibility that cancellation dynamics differ by care setting, encounters were classified as ambulatory (outpatient or day surgery) or short-stay or inpatient using the scheduled surgical patient class; the proportion in each setting was reported, and the primary model was refit, restricted to ambulatory encounters. To confirm that the tercile grouping did not drive the observed gradient, the model was refit with SVI entered as quartiles.

Among DoSCs, the cancellation reason documented in the structured electronic health record field was categorized into nine mutually exclusive groups: illness or clinical, COVID-19, pre-op cancellation of unspecified reason, no-show, refusal or change of mind, preparation or adherence, logistical or access-related, financial, and provider, system, or administrative. COVID-19 was retained as a distinct category given its relevance to the study period, and no-show was kept separate from pre-op cancellation to distinguish failure to arrive from cancellation after arrival. Categorization followed a predefined scheme, and the complete mapping of each documented reason to its category is provided in Online Resource 2. The distribution of reason categories was compared across SVI terciles using the Pearson chi-squared test. All analyses were performed in R (version 4.5.3; R Foundation for Statistical Computing, Vienna, Austria).

Results

After exclusions, 72,489 elective pediatric surgical encounters from 2020 through 2025 comprised the final cohort. Of these, 60,236 (83%) were completed as scheduled, 8,187 (11%) were canceled before the day of surgery, and 4,066 (5.6%) were canceled on the day of surgery.

The 72,489 encounters were contributed to by 50,546 unique patients (median 1 encounter per patient, interquartile range 1 to 2; maximum 33). The mean encounter age was 6.87 ± 5.69 years, and 59% were male. The cohort was predominantly White or Caucasian (77%) and non-Hispanic (84%), with Black or African American patients comprising 19%. Otolaryngology was the most represented specialty, accounting for 46% of encounters. The mean overall SVI percentile was 0.41 ± 0.31, and 49% of patients resided in neighborhoods in the lowest vulnerability tercile (Table 1).

Table 1
Demographic, socioeconomic, and clinical characteristics of the elective pediatric surgical cohort

Age, mean ± SD	**N**	**Total cases (N = 72,489)**
	72,487	**6.87 ± 5.69**
Unknown		2
Sex, n (%)	**72,485**	
Female		29,466 (41%)
Male		43,019 (59%)
Unknown		4
Race, n (%)	**70,171**	
American Indian or Alaska Native		413 (0.6%)
Asian		2,381 (3.4%)
Black or African American		13,495 (19%)
Native Hawaiian or Other Pacific Islander		163 (0.2%)
White or Caucasian		53,719 (77%)
Unknown		2,318
Ethnicity, n (%)	**71,464**	
Hispanic or Latino		11,246 (16%)
Not Hispanic or Latino		60,218 (84%)
Unknown		1,025
Season, n (%)	**72,489**	
Fall		17,498 (24%)
Spring		18,083 (25%)
Summer		18,448 (25%)
Winter		18,460 (25%)
SVI Overall, mean ± SD	72,338	0.41 ± 0.31
Unknown		151
SVI Theme 1: Socioeconomic Status, mean ± SD	72,339	0.38 ± 0.31

Continuous variables are mean ± SD; categorical variables are n (%). Percentages exclude encounters with missing or unknown values. SVI scores are national percentile rankings (0–1); higher values indicate greater neighborhood vulnerability. SD standard deviation, SVI Social Vulnerability Index

Age, mean ± SD	**N**	**Total cases (N = 72,489)**
	72,487	**6.87 ± 5.69**
SVI Theme 2: Household Characteristics, mean ± SD	72,339	0.46 ± 0.29
SVI Theme 3: Racial and Ethnic Minority Status, mean ± SD	72,339	0.41 ± 0.29
SVI Theme 4: Housing & Transportation, mean ± SD	72,338	0.47 ± 0.28
SVI Tercile, n (%)	**72,338**	
Less than 33%		35,136 (49%)
33–66%		18,833 (26%)
67–100%		18,369 (25%)
Unknown		151
Provider Primary Specialty, n (%)	**72,489**	
Cardiothoracic Surgery		1,134 (1.6%)
General Surgery		9,396 (13%)
Neurosurgery		1,293 (1.8%)
Ophthalmology		4,610 (6.4%)
Orthopedic Surgery		8,333 (11%)
Otolaryngology		33,355 (46%)
Plastic Surgery		4,590 (6.3%)
Urology		9,778 (13%)

Continuous variables are mean ± SD; categorical variables are n (%). Percentages exclude encounters with missing or unknown values. SVI scores are national percentile rankings (0–1); higher values indicate greater neighborhood vulnerability. SD standard deviation, SVI Social Vulnerability Index

Demographic and clinical characteristics differed significantly across the three outcome groups (Table 2). Patients with DoSCs were younger than those with non-DoSCs (6.12 ± 5.29 vs 6.76 ± 5.83 years, $p < 0.001$) and those whose cases were completed (6.12 ± 5.29 vs 6.94 ± 5.69 years, $p < 0.001$) and were more likely to be male (64% vs 59%, $p < 0.001$). Racial distribution differed across groups ($p < 0.001$; Fig. 1).**Fig. 1.** Racial distribution across surgical encounter outcomes. Stacked bars show the proportional racial composition within each outcome category: total cohort, completed cases, non-day-of-surgery cancellations, and day-of-surgery cancellations. Encounters with unknown race were excluded. Percentage labels indicate the share of Black or African American patients in each category, illustrating the rise from 19.2% of total encounters to 35.6% of day-of-surgery cancellations. DoSC = day-of-surgery cancellation; non-DoSC = non-day-of-surgery cancellation. Black or African American patients

comprised 19% of the cohort but 36% of DoSCs, compared with 18% of completed cases, while White or Caucasian patients accounted for 59% of DoSCs compared with 78% of completed cases.

Table 2
Patient characteristics by cancellation outcome

Age, mean ± SD	**N**	**Overall (N = 72,489)**	**Completed Case (N = 60,236)**	**Non-Day-of-Surgery Cancellation (N = 8,187)**	**Day-of-Surgery Cancellation (N = 4,066)**	**p-value**
	72,487	**6.87 ± 5.69**	**6.94 ± 5.69**	**6.76 ± 5.83**	**6.12 ± 5.29**	**< 0.001**
Unknown		2	0	1	1	
Sex, n (%)	**72,485**					**< 0.001**
Female		29,466 (41%)	24,752 (41%)	3,234 (40%)	1,480 (36%)	
Male		43,019 (59%)	35,483 (59%)	4,952 (60%)	2,584 (64%)	
Unknown		4	1	1	2	
Race, n (%)	**70,171**					**< 0.001**
American Indian or Alaska Native		413 (0.6%)	341 (0.6%)	41 (0.5%)	31 (0.8%)	
Asian		2,381 (3.4%)	1,897 (3.2%)	326 (4.1%)	158 (4.0%)	
Black or African American		13,495 (19%)	10,487 (18%)	1,616 (21%)	1,392 (36%)	
Native Hawaiian or Other Pacific Islander		163 (0.2%)	134 (0.2%)	16 (0.2%)	13 (0.3%)	
White or Caucasian		53,719 (77%)	45,520 (78%)	5,879 (75%)	2,320 (59%)	
Unknown		2,318	1,857	309	152	
Season, n (%)	**72,489**					**< 0.001**
Fall		17,498 (24%)	14,727 (24%)	1,819 (22%)	952 (23%)	

Continuous variables are mean ± SD; categorical variables are n (%). p-values are three-group comparisons (completed, non-day-of-surgery cancellation, day-of-surgery cancellation) using Kruskal-Wallis tests for continuous and Pearson chi-squared tests for categorical variables. Percentages exclude missing or unknown values. SD standard deviation, SVI Social Vulnerability Index

Age, mean ± SD	**N**	**Overall (N = 72,489)**	**Completed Case (N = 60,236)**	**Non-Day-of-Surgery Cancellation (N = 8,187)**	**Day-of-Surgery Cancellation (N = 4,066)**	**p-value**
	72,487	**6.87 ± 5.69**	**6.94 ± 5.69**	**6.76 ± 5.83**	**6.12 ± 5.29**	**< 0.001**
Spring		18,083 (25%)	14,606 (24%)	2,473 (30%)	1,004 (25%)	
Summer		18,448 (25%)	15,703 (26%)	1,818 (22%)	927 (23%)	
Winter		18,460 (25%)	15,200 (25%)	2,077 (25%)	1,183 (29%)	
SVI Overall, mean ± SD	72,338	0.41 ± 0.31	0.40 ± 0.30	0.43 ± 0.31	0.53 ± 0.32	< 0.001
Unknown		151	121	19	11	
SVI Theme 1: Socioeconomic, mean ± SD	72,339	0.38 ± 0.31	0.37 ± 0.30	0.39 ± 0.31	0.50 ± 0.33	< 0.001
SVI Theme 2: Household, mean ± SD	72,339	0.46 ± 0.29	0.45 ± 0.29	0.47 ± 0.29	0.54 ± 0.30	< 0.001
SVI Theme 3: Racial/Ethnic Minority, mean ± SD	72,339	0.41 ± 0.29	0.40 ± 0.29	0.42 ± 0.30	0.52 ± 0.32	< 0.001
SVI Theme 4: Housing & Transportation, mean ± SD	72,338	0.47 ± 0.28	0.46 ± 0.27	0.58 ± 0.28	0.53 ± 0.27	< 0.001
SVI Tercile, n (%)	**72,338**					**< 0.001**
Less than 33%		35,136 (49%)	29,925 (50%)	3,823 (47%)	1,388 (34%)	
33–66%		18,833 (26%)	15,745 (26%)	2,103 (26%)	985 (24%)	
67–100%		18,369 (25%)	14,445 (24%)	2,242 (27%)	1,682 (41%)	

Continuous variables are mean ± SD; categorical variables are n (%). p-values are three-group comparisons (completed, non-day-of-surgery cancellation, day-of-surgery cancellation) using Kruskal-Wallis tests for continuous and Pearson chi-squared tests for categorical variables. Percentages exclude missing or unknown values. SD standard deviation, SVI Social Vulnerability Index

Age, mean ± SD	N	Overall (N = 72,489)	Completed Case (N = 60,236)	Non-Day-of-Surgery Cancellation (N = 8,187)	Day-of-Surgery Cancellation (N = 4,066)	p-value
	72,487	**6.87 ± 5.69**	**6.94 ± 5.69**	**6.76 ± 5.83**	**6.12 ± 5.29**	**< 0.001**
Unknown		151	121	19	11	

Continuous variables are mean ± SD; categorical variables are n (%). p-values are three-group comparisons (completed, non-day-of-surgery cancellation, day-of-surgery cancellation) using Kruskal-Wallis tests for continuous and Pearson chi-squared tests for categorical variables. Percentages exclude missing or unknown values. SD standard deviation, SVI Social Vulnerability Index

Patients with DoSCs resided in more socially vulnerable neighborhoods than those with non-DoSCs or completed cases. The mean overall SVI was 0.53 ± 0.32 among DoSCs, 0.43 ± 0.31 among non-DoSCs, and 0.40 ± 0.30 among completed cases ($p < 0.001$). This gradient held across all four SVI themes: socioeconomic status (0.50 ± 0.33 vs 0.37 ± 0.30), household characteristics (0.54 ± 0.30 vs 0.45 ± 0.29), racial and ethnic minority status (0.52 ± 0.32 vs 0.40 ± 0.29), and housing and transportation (0.53 ± 0.27 vs 0.46 ± 0.27; all $p < 0.001$, same-day vs completed; Table 2).

The DoSC rate increased across SVI terciles, from 4.0% in the lowest to 5.2% in the middle and 9.2% in the highest ($p < 0.001$). The overall cancellation rate followed the same pattern, rising from 15% to 16% to 21% ($p < 0.001$; Online Resource 3).

Across 14 of 16 individual SVI measures, patients with DoSCs resided in neighborhoods with a higher prevalence of social disadvantage indicators. The largest absolute differences were in racial and ethnic minority composition (+ 13.3 percentage points), neighborhood poverty (+ 7.5), housing cost burden (+ 5.0), and lack of vehicle access (+ 3.6). Mobile home prevalence (− 0.2) and the proportion of residents aged 65 or older (− 1.8) did not follow this pattern (Fig. 2).**Fig. 2.** Neighborhood-level social determinants of health: mean difference between day-of-surgery cancellations and completed cases. Each bar shows the mean absolute difference in percentage points between encounters resulting in day-of-surgery cancellation and those completed as scheduled, calculated across the 16 census tract-level component variables of the CDC Social Vulnerability Index. Variables are organized by the four thematic domains. Positive values indicate higher neighborhood-level prevalence among day-of-surgery cancellations; negative values indicate lower prevalence

Same-day and overall cancellation rates differed across specialties ($p < 0.001$). General surgery had the highest same-day rate (7.0%), followed by urology (6.7%); urology had the highest overall rate (13.2%). Orthopedic surgery had the lowest same-day (3.9%) and overall (8.6%) rates. Otolaryngology, accounting for 46% of encounters, had a same-day rate of 5.4%, near the cohort average.

Cancellation rates varied across the study period. The overall cancellation rate was highest in 2020 (25.2%) and declined to between 13% and 15% from 2023 through 2025. The DoSC rate peaked in 2022

at 7.1% and declined to 4.9% by 2025. COVID-19 accounted for 24.1%, 33.2%, and 36.6% of DoSCs in 2020, 2021, and 2022, respectively, and fell below 1% in each year from 2023 onward (Table 3).

Table 3
Elective surgical volume and cancellations by encounter year, 2020–2025

Year	Elective cases	Any cancellation, n (%)	Same-day, n (%)	COVID-19, % of same-day
2020	10,002	2,525 (25.2)	638 (6.38)	24.1
2021	10,380	1,719 (16.6)	621 (5.98)	33.2
2022	12,111	2,453 (20.3)	855 (7.06)	36.6
2023	12,853	1,731 (13.5)	643 (5.00)	0.9
2024	13,679	1,786 (13.1)	655 (4.79)	0.5
2025	13,464	2,039 (15.1)	654 (4.86)	0.2
Total	**72,489**	**12,253 (16.9)**	**4,066 (5.61)**	**16.8**

Values are n (%) unless otherwise indicated. The final column indicates the proportion of same-day cancellations in each year attributed to COVID-19.

In the primary multivariable model comparing DoSCs with all other elective encounters (completed and non-DoSCs; n = 70,031), higher overall SVI was independently associated with DoSC (OR 2.20, 95% CI 1.94–2.49, p < 0.001). Black or African American race was associated with higher odds relative to White or Caucasian race (OR 1.89, 95% CI 1.74–2.07, p < 0.001), as were Asian race (OR 1.42, 95% CI 1.20–1.67, p < 0.001) and American Indian or Alaska Native race (OR 1.57, 95% CI 1.09–2.26, p = 0.015; n = 31). Native Hawaiian or Other Pacific Islander race was not significantly associated (OR 1.66, 95% CI 0.92–2.97, p = 0.091). Winter was associated with higher odds (OR 1.20, 95% CI 1.09–1.31, p < 0.001) and summer with lower odds (OR 0.90, 95% CI 0.82–0.99, p = 0.036) relative to fall, and encounter year was inversely associated with DoSC (OR 0.94, 95% CI 0.92–0.96, p < 0.001; Fig. 3).

In the secondary model restricted to cancelled cases (DoSC vs non-DoSC; n = 11,766), higher overall SVI remained associated with DoSC (OR 1.84, 95% CI 1.59–2.13, p < 0.001), as did Black or African American race (OR 1.74, 95% CI 1.57–1.94, p < 0.001) and American Indian or Alaska Native race (OR 1.64, 95% CI 1.02–2.64, p = 0.042; n = 31). Asian and Native Hawaiian or Other Pacific Islander race was not significantly associated. Spring was associated with lower odds relative to fall (OR 0.79, 95% CI 0.70–0.88, p < 0.001). The odds that a cancellation occurred on the day of surgery, rather than before it, increased per encounter year (OR 1.06, 95% CI 1.03–1.08, p < 0.001; Fig. 4).

Composite SVI was strongly correlated with its racial and ethnic minority theme (r = 0.84) and moderately correlated with Black race (r = 0.58). In a sensitivity model replacing the composite SVI with its three non-race themes, the association between Black race and DoSC was essentially unchanged (OR 1.87, 95% CI 1.71–2.03). Among the themes, the socioeconomic theme was independently associated

with DoSC (OR 2.07, 95% CI 1.74–2.47, p < 0.001), whereas the household characteristics (OR 1.08, p = 0.38) and housing and transportation themes (OR 1.07, p = 0.37) were not (Table 4).

Table 4
Cluster-robust multivariable models of same-day cancellation: composite SVI versus theme-decomposed specification

Characteristic	Composite model, OR (95% CI)	p	Theme-decomposed, OR (95% CI)	p
Race/ethnicity				
White or Caucasian	Reference		Reference	
American Indian or Alaska Native	1.57 (1.09–2.26)	0.015	1.59 (1.10–2.28)	0.013
Asian	1.42 (1.20–1.67)	< 0.001	1.43 (1.21–1.69)	< 0.001
Black or African American	1.89 (1.74–2.07)	< 0.001	1.87 (1.71–2.03)	< 0.001
Native Hawaiian or Other Pacific Islander	1.66 (0.92–2.97)	0.091	1.66 (0.92–2.98)	0.092
Composite SVI (overall percentile)	2.20 (1.94–2.49)	< 0.001	—	
SVI socioeconomic theme	—		2.07 (1.74–2.47)	< 0.001
SVI household theme	—		1.08 (0.91–1.27)	0.382
SVI housing/transportation theme	—		1.07 (0.92–1.26)	0.373

Multivariable logistic regression for same-day cancellation; both models adjusted for season and encounter year, with cluster-robust 95% CIs clustered on medical record number. n = 70,031. The racial and ethnic minority SVI theme is omitted from the theme-decomposed model for its collinearity with race (r = 0.84 with the composite index; r = 0.58 with Black race). OR odds ratio, CI confidence interval, SVI Social Vulnerability Index

The SVI and race associations were consistent when the primary model was fit separately by era. In 2020 to 2022 (n = 31,423), higher SVI (OR 2.09, 95% CI 1.77–2.47) and Black or African American race (OR 1.83, 95% CI 1.63–2.05) were associated with DoSC; estimates were similar in 2023 to 2025 (n = 38,608; SVI OR 2.36, 95% CI 1.96–2.83; Black race OR 1.97, 95% CI 1.73–2.23) (Online Resource 4).

The primary association was robust across prespecified sensitivity analyses (Online Resource 5). Adding age and sex to the model left the estimates essentially unchanged (SVI OR 2.22, 95% CI 1.96–2.51; Black race OR 1.88, 95% CI 1.72–2.05); younger age and male sex were each independently associated with DoSC. Ambulatory encounters comprised 53,554 (73.9%) of the cohort and short-stay or inpatient encounters 18,935 (26.1%), with similar DoSC rates (5.5% and 5.8%, respectively); restricting the model to ambulatory encounters yielded similar estimates (SVI OR 2.29, 95% CI 1.98–2.65; Black race OR 1.98,

95% CI 1.78–2.19). Modeling SVI in quartiles reproduced the gradient, with adjusted odds rising across the second, third, and highest quartiles relative to the lowest (OR 1.06, 1.28, and 1.78).

Among DoSCs, the documented reason differed across SVI terciles ($p < 0.001$; Table 5). No-show accounted for an increasing share across the lowest, middle, and highest terciles (2.7%, 6.1%, and 14.1%), as did refusal or change of mind (6.8%, 10.6%, 13.3%) and preparation or adherence issues (4.3%, 5.7%, 10.7%). Conversely, illness or other clinical reasons accounted for a decreasing share (38.8%, 31.0%, 21.3%). Reasons coded as logistical or access-related, including transportation and weather, accounted for fewer than 3% of same-day cancellations in every tercile.

Table 5
Same-day cancellation reasons by neighborhood SVI tercile

Cancellation reason	**Low SVI < 0.33 (n = 1,388)**	**Middle SVI 0.33–0.67 (n = 985)**	**High SVI ≥ 0.67 (n = 1,682)**	**Overall (N = 4,055)**
Illness/clinical	538 (38.8)	305 (31.0)	358 (21.3)	1,201 (29.6)
COVID-19	236 (17.0)	172 (17.5)	275 (16.3)	683 (16.8)
Pre-op cancellation (unspecified)	218 (15.7)	155 (15.7)	213 (12.7)	586 (14.5)
No-show	37 (2.7)	60 (6.1)	238 (14.1)	335 (8.3)
Refusal/changed mind	95 (6.8)	104 (10.6)	224 (13.3)	423 (10.4)
Preparation/adherence	60 (4.3)	56 (5.7)	180 (10.7)	296 (7.3)
Logistical/access	8 (0.6)	21 (2.1)	47 (2.8)	76 (1.9)
Financial	40 (2.9)	23 (2.3)	18 (1.1)	81 (2.0)
Provider/system/administrative	156 (11.2)	89 (9.0)	129 (7.7)	374 (9.2)
Total	**1,388**	**985**	**1,682**	**4,055**

Values are n (column %); percentages are within each SVI tercile. Of 4,066 same-day cancellations, 11 with missing SVI were excluded. Pearson chi-squared = 336.7, df = 16, $p < 0.001$. SVI Social Vulnerability Index

Discussion

Day-of-surgery cancellations have emerged as a marker of inequity in pediatric surgical care, with neighborhood disadvantage and race identified as predictors of cancellation risk [7, 8]. In this multispecialty cohort, DoSC occurred in 5.6% of elective encounters overall and in 9.2% of elective encounters from the most socially vulnerable neighborhoods, and the association with neighborhood vulnerability persisted after multivariable adjustment. These findings align with Willer and colleagues, who reported higher DoSC among children from lower-opportunity neighborhoods, with Black children at

elevated risk independent of neighborhood opportunity, and with Santucci and colleagues, who described similar patterns across a multi-site health system, including a concentration of no-show and preoperative cancellations among children from [7, 8] the least advantaged neighborhoods [8]. Both prior studies used the Child Opportunity Index and focused on ambulatory populations.

The present study corroborates these findings and extends them in three respects. First, it measures neighborhood disadvantage with the CDC Social Vulnerability Index, a federal instrument linkable to residential address, and decomposes it into its constituent themes; with the racial and ethnic minority theme excluded for its collinearity with race, the socioeconomic theme accounted for the association while the household and the housing and transportation themes did not, localizing the relevant dimension of disadvantage more precisely than a composite measure allows. Second, although prior studies likewise drew on multiple specialties, both were confined to ambulatory or same-day surgical populations; here the association was confirmed across the full elective surgical caseload of a freestanding tertiary children's hospital, spanning eight specialties and more than 72,000 encounters and including procedures, such as those in cardiothoracic surgery and neurosurgery, that typically require admission, indicating that the pattern extends beyond ambulatory care to pediatric elective surgery more broadly. Third, it encompasses the COVID-19 pandemic and the subsequent period, an interval excluded from the most comparable prior study, and shows through era-stratified models that the association holds in both. The categorization of documented cancellation reasons across vulnerability strata is consistent with the reason-level disparities Santucci and colleagues reported [8], reinforcing that pattern.

The racial disparities in this cohort were pronounced. Black or African American children accounted for roughly twice their share of the cohort among DoSCs, and this overrepresentation persisted after adjustment for neighborhood social vulnerability, season, and encounter year. This is consistent with previous studies, which identified Black race as strongly associated with DoSC independent of neighborhood measures [7, 8]. That race remained an independent predictor after adjustment for neighborhood vulnerability warrants structural consideration.

Neighborhood social vulnerability showed a graded association with DoSC, with rates more than doubling from the least to the most vulnerable tercile, and the association remained after adjustment. Although DoSCs were associated with greater vulnerability across all four SVI themes in unadjusted comparisons, the themes were not equally informative when modeled together. The socioeconomic theme carried an independent association, whereas the household composition and the housing and transportation themes did not. This pattern suggests that the risk captured by the composite index may reflect socioeconomic disadvantage more than housing or transportation infrastructure, and it argues against attributing cancellation primarily to transportation barriers alone.

That Black race remained associated with cancellation after adjustment for neighborhood vulnerability invites a structural interpretation. Area-based indices capture meaningful features of neighborhood context. Still, they cannot fully represent the cumulative effects of residential segregation, historical disinvestment, and related policies that have shaped the material conditions of many Black communities

and that persist beyond the formal end of discriminatory policy [19, 20]. Williams and Collins described racial residential segregation as a fundamental cause of health disparities, with downstream effects on access and opportunity that composite indices approximate but do not fully capture [21]. Viewed this way, the residual association may reflect structural inequities that originate well before the perioperative encounter rather than any patient-level characteristic, and addressing it will require approaches that extend beyond perioperative scheduling.

The association between vulnerability and cancellation was evident across the full range of pediatric surgical specialties rather than concentrated in one. Every specialty drew patients from across the spectrum of neighborhood vulnerability, and the pooled association was substantial. This breadth is consistent with cancellation arising from upstream factors that operate across specialties, such as the socioeconomic constraints and appointment-engagement barriers reflected in the reason analysis, rather than from the operative complexity or scheduling practices of a particular service. These findings are consistent with social vulnerability operating as a system-level contributor to cancellation across pediatric surgical care.

The consequences of cancellation, although not measured in this study, are documented across stakeholders in prior work. For families, pediatric cancellations have been associated with financial strain and distress, including anxiety and diminished trust [22]. For institutions, unused operating room time represents substantial lost capacity and revenue [5]. For children, delayed care may matter for certain time-sensitive procedures [6]. Our data cannot establish that these consequences followed the cancellations observed here, but to the extent that they occur, they would tend to fall most heavily on the families already most likely to experience cancellation, potentially compounding existing disadvantage. Notably, DoSC rates continued to decline after 2022, when COVID-19 had become a negligible contributor, suggesting that factors beyond the pandemic, such as evolving scheduling and preoperative preparation practices, also contributed to the improvement.

These findings have practical implications for how cancellation risk might be anticipated. Because the SVI is publicly available and linkable to residential address, it can, in principle, be incorporated into scheduling workflows to flag encounters at elevated neighborhood-level risk before the day of surgery rather than after. The reason analysis suggests that the modifiable component of this risk lies less in transportation than in appointment engagement, since no-show and preparation-related reasons, rather than documented transportation barriers, accounted for the rising share of cancellations with greater vulnerability. Engagement-oriented strategies such as structured preoperative contact, reminder and navigation support, and language-concordant communication are therefore plausible candidates for prospective evaluation. We frame these as hypotheses rather than recommendations; this observational study identifies which encounters are at risk, not which interventions will reduce that risk, and any such program would warrant prospective testing before adoption.

The study period spanned the COVID-19 pandemic, which shaped these trends. Overall and DoSC rates were elevated early in the period, and COVID-19 itself accounted for roughly a quarter to a third of DoSCs

during 2020 through 2022 before becoming negligible thereafter. Both rates declined as the pandemic receded. To assess whether the association with social vulnerability was an artifact of this period, the primary model was fit separately within the pandemic and post-pandemic eras; the association was present and similar in magnitude in both, indicating that it does not depend on the disruptions of the pandemic. The earlier observation that, among cancellations, the proportion occurring on the day of surgery rose over time reflects a faster decline in non-DoSCs than in DoSCs, not an increase in DoSC itself.

This study has several limitations that warrant consideration. As a single-institution retrospective study at an urban Midwestern tertiary children's hospital, the findings may not generalize to other settings. Cancellation reasons came from a structured electronic health record field rather than patient report, so the categories are coarse and identify documented reasons rather than underlying causes; reasons were available only for DoSC, and non-DoSC, used here only as a comparison group, may include administrative events such as rescheduling or insurance issues. Neighborhood disadvantage was measured at the census tract level using the 2020 SVI, which is subject to the ecological fallacy and may not reflect change over time. Cases that could not be geocoded were excluded, and the surgical specialty was omitted from the models as a likely mediator. Patient-level language, insurance, and travel distance were not modeled. Finally, because race and the SVI are correlated, their independent contributions cannot be fully separated, although the theme-decomposed suggests the race association is not an artifact of the index.

Conclusion

In a multispecialty cohort of elective pediatric surgical encounters, neighborhood social vulnerability and Black race were each independently associated with DoSC. The breadth of the association across eight specialties supports a system-level interpretation in which upstream social determinants operate alongside specialty-specific factors, and the persistence of race after adjustment for neighborhood vulnerability reflects the close and historically rooted relationship between race and social disadvantage in the United States. Because the SVI is publicly available and linkable to residential address, it may offer a practical basis for anticipating cancellation risk at the point of scheduling, a possibility that warrants prospective evaluation alongside engagement-focused interventions.

Declarations

Conflict of Interest Declaration

The authors declare no competing financial or personal interests.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Ethics approval: This study was approved by the Institutional Review Board of Children's Wisconsin and the Medical College of Wisconsin (protocol PRO00050562) and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Consent to participate: The requirement for informed consent was waived by the Institutional Review Board due to the retrospective nature of the study and the use of de-identified data.

Data availability: The data that support the findings of this study contain protected health information and are not publicly available. De-identified data may be made available from the corresponding author upon reasonable request and with the approval of the Children's Wisconsin Institutional Review Board.

Author contributions: Kaleb M. Keener: Conceptualization, Methodology, Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review and editing. Brian J. Conway: Writing – review and editing. Haley Anderson Feltracco: Writing – review and editing. Mackenzie R. O'Connell: Data curation, Investigation, Writing – review and editing. Carisa Bergner: Methodology, Formal analysis, Supervision, Writing – review and editing. Martin Bantchev: Data curation, Investigation, Writing – review and editing. Emmanuel L. Abebrese: Conceptualization, Methodology, Supervision, Writing – review and editing. Kristen Klement: Methodology, Supervision, Writing – review and editing. David Gourlay: Conceptualization, Methodology, Supervision, Project administration, Writing – review and editing.

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Figures

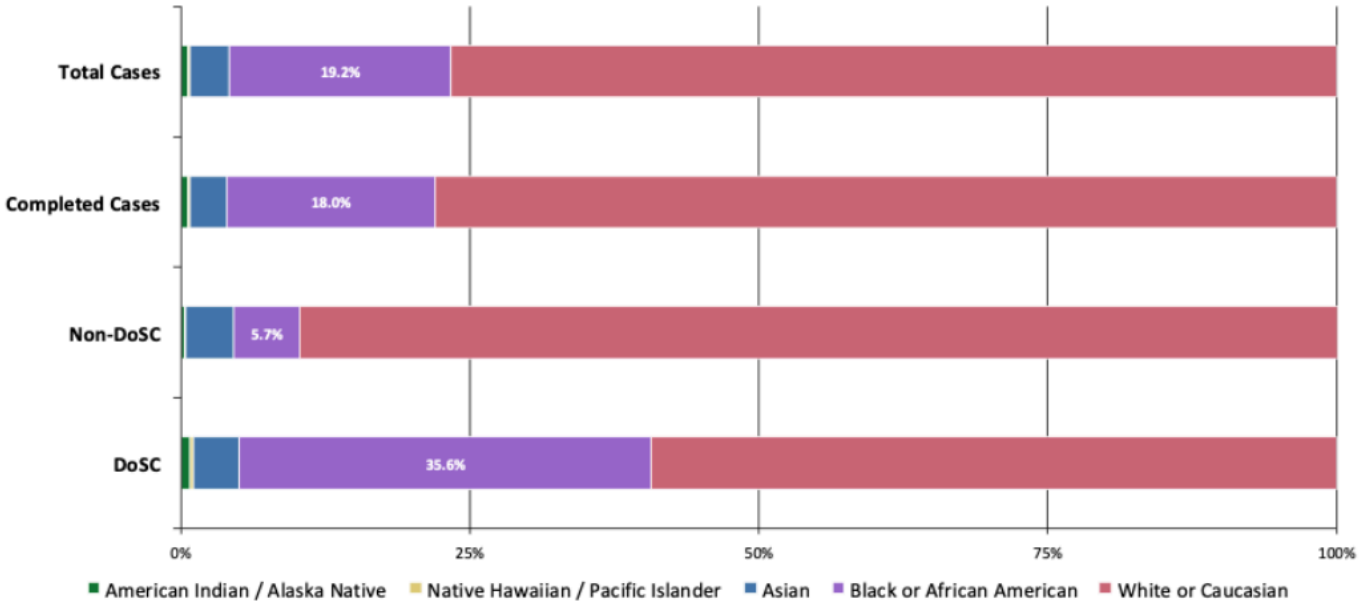


Figure 1

Racial distribution across surgical encounter outcomes. Stacked bars show the proportional racial composition within each outcome category: total cohort, completed cases, non-day-of-surgery cancellations, and day-of-surgery cancellations. Encounters with unknown race were excluded. Percentage labels indicate the share of Black or African American patients in each category, illustrating the rise from 19.2% of total encounters to 35.6% of day-of-surgery cancellations. DoSC = day-of-surgery cancellation; non-DoSC = non-day-of-surgery cancellation. Black or African American patients comprised 19% of the cohort but 36% of DoSCs, compared with 18% of completed cases, while White or Caucasian patients accounted for 59% of DoSCs compared with 78% of completed cases.

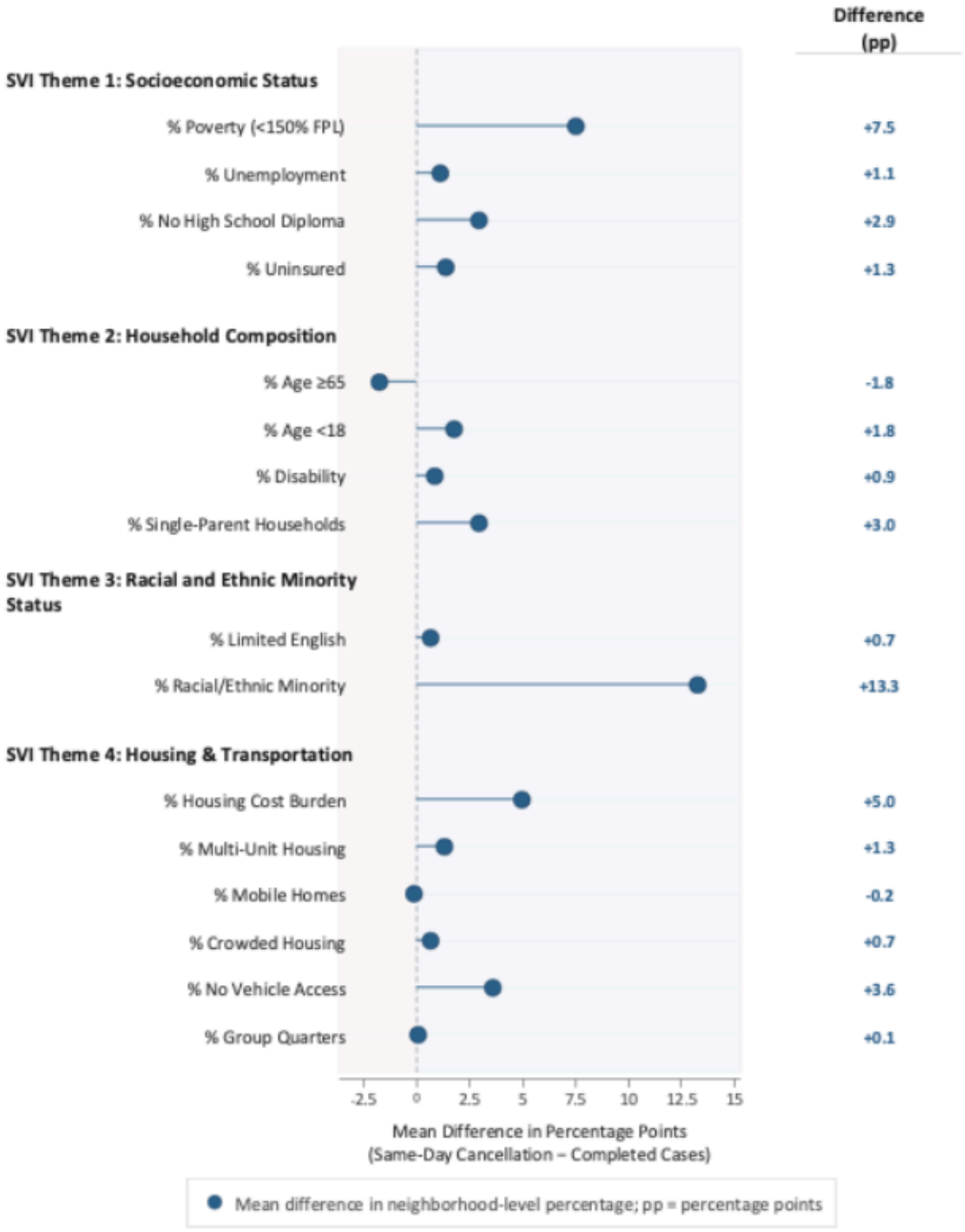


Figure 2

Neighborhood-level social determinants of health: mean difference between day-of-surgery cancellations and completed cases. Each bar shows the mean absolute difference in percentage points between encounters resulting in day-of-surgery cancellation and those completed as scheduled, calculated across the 16 census tract-level component variables of the CDC Social Vulnerability Index. Variables are

organized by the four thematic domains. Positive values indicate higher neighborhood-level prevalence among day-of-surgery cancellations; negative values indicate lower prevalence

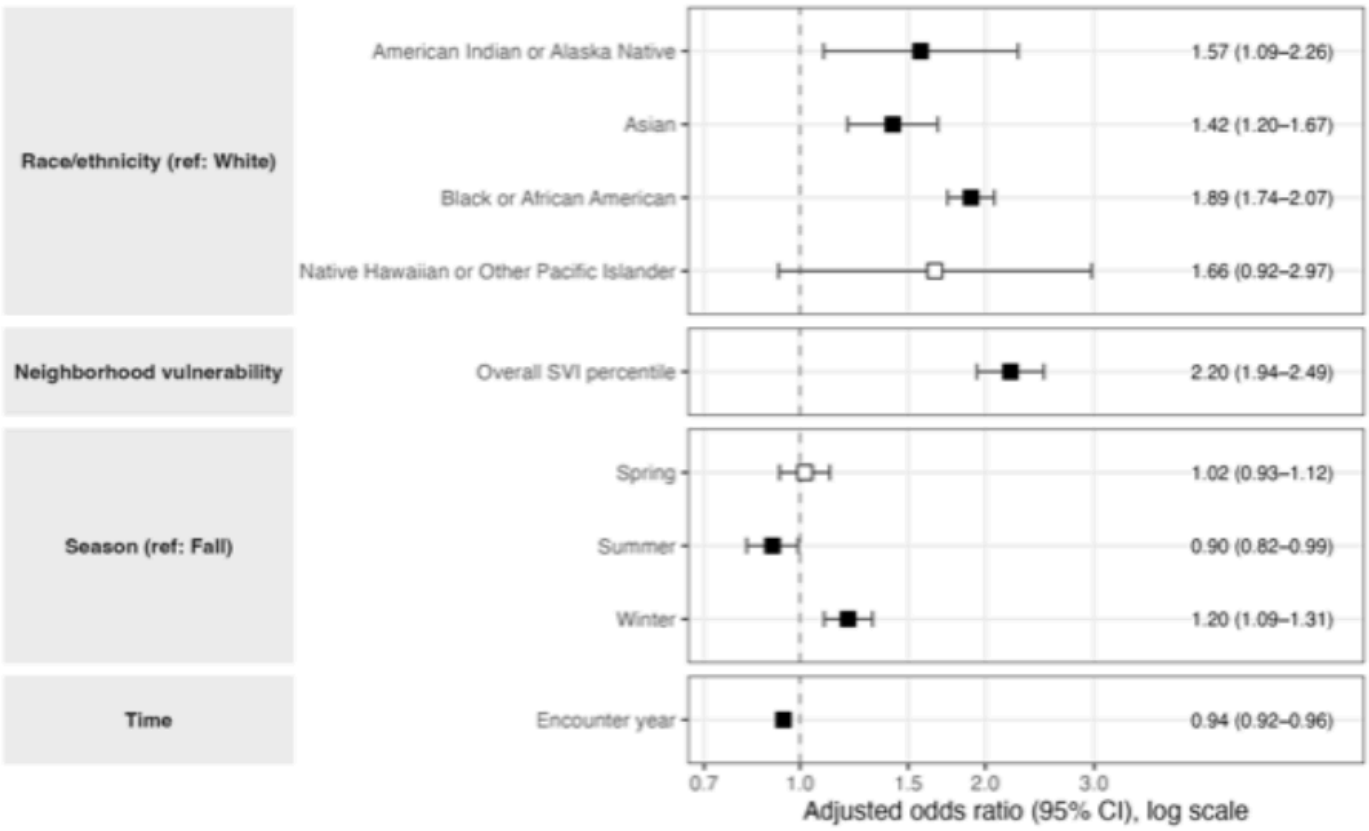


Figure 3

Multivariable logistic regression of day-of-surgery cancellation versus all other elective encounters. Forest plot of adjusted odds ratios with 95% confidence intervals from a multivariable logistic regression model comparing day-of-surgery cancellations with all other elective encounters (completed procedures and non-same-day cancellations combined). The reference category for race is White or Caucasian; the reference season is fall. Overall Social Vulnerability Index ranking is scaled from 0 to 1, with higher values indicating greater neighborhood-level vulnerability; encounter year is entered as a continuous predictor. Confidence intervals are cluster-robust, accounting for repeated encounters within patients. Filled markers denote statistical significance at $p < 0.05$.

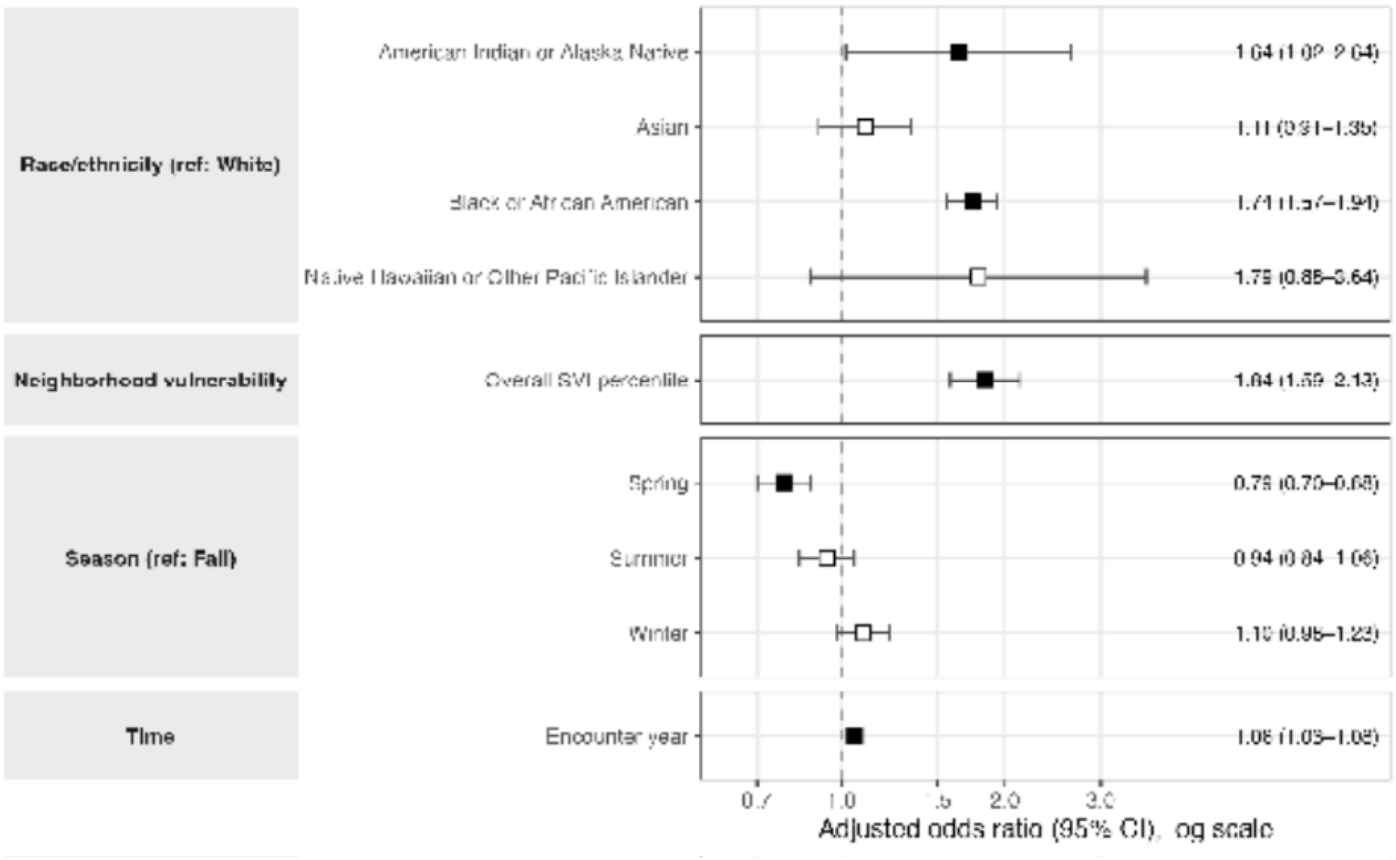


Figure 4

Multivariable logistic regression of day-of-surgery cancellation versus non-same-day cancellation. Forest plot of adjusted odds ratios with 95% confidence intervals from a multivariable logistic regression model restricted to cancelled cases, comparing day-of-surgery cancellations with non-same-day cancellations. The reference category for race is White or Caucasian; the reference season is fall. Overall Social Vulnerability Index ranking is scaled from 0 to 1, with higher values indicating greater neighborhood-level vulnerability; encounter year is entered as a continuous predictor. Confidence intervals are cluster-robust, accounting for repeated encounters within patients. Filled markers denote statistical significance at $p < 0.05$.

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