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Program-Level Predictors of Bariatric Surgery Volume Resilience During the GLP-1 Receptor Agonist Era: A Mixed-Methods Survey and Registry Analysis

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Abstract

Background:

Bariatric surgery volumes have declined substantially during the GLP-1 receptor agonist era, yet whether program-level operational characteristics predict which sites maintain volume is unknown. Self-reported volume trajectory has not been validated against registry measurement.

Methods:

Mixed-methods study combining a 30-item program-level survey of a surgical collaborative sites (34 of 42; 81%) with registry data spanning 2015–2025 (136,025 cases); 32 sites were linked to registry trajectories. Resilience was classified by pre/post percent change in annual volume (pre: 2019, 2021, 2022; post: 2023–2025). Concordance with survey self-report was assessed with Cohen's kappa. Associations between program characteristics and registry volume change were tested with Fisher's exact and Wilcoxon rank-sum tests. Multivariable Firth penalized logistic regression examined independent predictors of resilience.

Results

Of 32 linked sites, 21 (66%) had registry-confirmed volume decline (≥ 5% decrease). Concordance between self-report and registry trajectory was poor (agreement 59%, κ = 0.10). Primary case volume collapsed 44% from the 2022 peak while revision volume declined only 18%; revision share grew from 9% to 16%. Programs not prescribing GLP-1 agonists had significantly more favorable volume change than prescribers (median + 9.2% vs − 21.6%; P = 0.033), likely reflecting confounding by program structure. No integration model, staffing pattern, or payer environment variable independently predicted resilience. Resilient programs consistently described integrated medical–surgical clinics with internal referral pathways after GLP-1 non-response.

Conclusions

Self-reported volume trajectory has near-zero concordance with registry measurement. The GLP-1 era disproportionately affected primary surgical candidates while sparing revision patients. Objective registry-based benchmarking is essential for quality improvement addressing bariatric volume trends.

INTRODUCTION

Bariatric surgery volumes have declined substantially across the United States since 2022, coinciding with rapid adoption of glucagon-like peptide-1 receptor agonist (GLP-1 RA) medications for obesity management.[1–3] In the most recent American Society for Metabolic and Bariatric Surgery procedural

volume assessment, metabolic and bariatric surgery volume in the United States decreased by nearly 25% in 2024 compared with 2022, with 72% of states experiencing a volume drop of more than 15%.[4,5] Similar declines have been documented nationally in inpatient utilization data and payer claims analyses.[6,7]

The temporal coincidence of GLP-1 RA proliferation and surgical volume decline has led to widespread assumption that medical therapy is replacing surgical management of obesity, despite evidence of the durable long-term benefits of bariatric surgery.[8–10] However, the relationship may be more nuanced. In national claims data, GLP-1 RA prescribing roughly doubled between 2022 and 2023 while bariatric surgery declined by approximately 9%, yet patients undergoing surgery carried substantially more comorbidity than those receiving medication, suggesting the two therapies serve partly distinct populations.[7] Preliminary registry work has similarly found that GLP-1 RA use among bariatric surgery patients does not explain program-level volume decline, raising the possibility that GLP-1 prescribing is a marker of integrated obesity care rather than a competing therapy. Registry data alone, however, cannot capture program-level operational characteristics.

Understanding why some programs maintain surgical volume during the GLP-1 era while others decline is essential for quality improvement. The explanations proposed for volume decline (GLP-1 RA diversion of surgical candidates,[7] reduced primary care referrals, payer coverage changes, shifting patient preferences, and staffing reductions) each imply different programmatic responses. If the decline reflects structural and operational differences between programs, collaborative-wide dissemination of effective models could partially mitigate volume loss.

A further methodological concern is whether programs can reliably self-assess their own volume trajectory. Quality improvement collaboratives frequently rely on self-reported program characteristics for benchmarking and performance improvement.[11,12] When self-reported volume trends differ from objectively measured registry data, further evaluation may be warranted to better understand the degree of alignment between these data sources.

We conducted a mixed-methods study combining a comprehensive program-level survey with 10 years of registry data to (1) characterize program-level responses to the GLP-1 era, (2) assess concordance between self-reported and registry-measured volume trajectory, (3) identify program characteristics associated with volume resilience, and (4) describe the operational models employed by programs that maintained surgical throughput.

METHODS

Study Design and Setting

This mixed-methods study integrated a cross-sectional program-level survey with retrospective analysis of prospectively collected registry data from a surgical collaborative.[13] The registry collects standardized

preoperative, perioperative, and postoperative data on all patients undergoing bariatric surgery at participating centers.

Survey Component

A 30-item survey was developed to capture program-level characteristics, operational changes, GLP-1 RA prescribing practices, referral environment, payer coverage changes, and perceived volume trajectory (eTable 8). The survey was distributed via Qualtrics (Qualtrics, Provo, UT) in March 2026 to all 42 participating sites and was completed jointly by the site coordinator and lead bariatric surgeon at each site. Sites prescribing GLP-1 RA medications completed additional items on prescribing patterns, patient selection criteria, integration model, and perceived impact. Open-ended items captured strategies that had or had not been effective in maintaining volume.

Forty-one of 42 sites (98%) initiated the survey, and 34 unique sites (81%) submitted complete responses (35 completed responses; one site submitted two responses, resolved by retaining the coordinator response).

Registry Component

Registry data included all bariatric procedures performed at participating sites from 2015 through 2025 (136,025 cases). Primary versus revision status was ascertained from the registry prior surgery flag (flg_sxprior: 0 = primary, 1 = revision/conversion). Procedure type was classified as sleeve gastrectomy, Roux-en-Y gastric bypass, biliopancreatic diversion with duodenal switch (BPD/DS), single-anastomosis duodeno-ileal bypass with sleeve gastrectomy (SIPS/SADI), or other.

Survey–Registry Linkage

Survey responses were linked to registry site identifiers using a name-based crosswalk that accounted for recent health-system rebranding (e.g., a program renamed after a health-system joint venture, matched to its prior registry identifier). Of 34 responding sites, 32 were linked to registry pre/post volume trajectories; two newly established programs began performing bariatric surgery in mid-2023 and 2025, respectively, and lacked pre-period volume for the pre/post comparison.

Resilience Classification

Site-level volume change was calculated as the percent change between the pre-period annual average (2019, 2021, 2022; excluding 2020 due to COVID-19) and the post-period annual average (2023, 2024, 2025). Sites were classified as Declined (> 5% decrease), Stable (± 5%), or Resilient (> 5% increase). Sensitivity analyses using a 10% threshold confirmed robustness (eTables 2–3). Registry-anchored classification was used for all analyses rather than survey self-report.

Statistical Analysis

Concordance between survey-reported and registry-measured volume trajectory was assessed with Cohen's kappa, collapsed to binary (decline vs. not decline) given sparse cell counts.[14] Sensitivity analyses assessed concordance at a 10% threshold and using primary-case-only volume change. Bivariate associations were tested using Fisher's exact tests and Wilcoxon rank-sum tests.[15] Spearman rank correlations assessed continuous associations. Multivariable predictors of resilience were examined using Firth penalized logistic regression[16,17] with models limited to 3–4 predictors given the small sample.[18] A linear regression of continuous percent change on survey factors was also conducted. All analyses used R version 4.3.0 with the logistf, data.table, and ggplot2 packages.[19,20] Two-sided P values less than 0.05 were considered statistically significant.

RESULTS

Survey Response and Program Characteristics

Forty-one of 42 sites (98%) initiated the survey, and 34 unique sites (81%) provided complete responses; 32 sites were linked to registry volume trajectories and constitute the analytic cohort. Self-reported program characteristics are summarized in Table 1.

Table 1
Survey Response Characteristics (N = 34 unique sites)

Characteristic	n	%
Volume trajectory (self-reported)		
Declined	29	85.3
Maintained	2	5.9
Increased	3	8.8
Prescribes GLP-1 RA	28	82.4
Payer coverage reversals	28	82.4
PCPs less likely to refer	21	61.8
Staffing reduced since 2023	18	52.9
No data-driven response	12	35.3
Major negative perceived impact*	19	67.9
* Denominator = 28 prescribing sites.		

Volume Trends and Primary vs. Revision Analysis

Collaborative-wide annual bariatric surgery volume peaked at 9,411 cases in 2022 and declined to 5,508 in 2025 (− 41.5%). Primary case volume declined 44.4% from the 2022 peak (8,357 to 4,643) while revision/conversion volume declined only 17.9% (1,054 to 865). Revision share increased from 9.1% to 15.7%, not because revision volume grew, but because primary volume contracted disproportionately (Fig. 1). Among the 32 linked analytic sites, 21 (66%) were classified as Declined, 5 (16%) as Stable, and 6 (19%) as Resilient.

Concordance Between Survey and Registry

Survey self-reported volume trajectory had poor concordance with registry-measured trajectory (Table 2). Raw agreement was 59.4% (19 of 32 sites) and Cohen's kappa was 0.10, indicating agreement barely above chance. Thirteen sites (40.6%) were discordant: 5 reported decline but were classified as Resilient by the registry, 4 reported decline but were Stable, 2 reported increased volume but were Declined or Stable (1 each), and 2 reported maintained volume but were Declined or Resilient (1 each) (Table 3, Fig. 2). Concordance was similarly poor in sensitivity analyses using a 10% threshold (κ = 0.08) and primary-case-only volume change (κ = 0.03; eTables 2–3).

Table 2
Concordance Between Survey and Registry Volume Trajectory (N = 32)

Survey: Declined	**Registry: Declined**	**Registry: Stable**	**Registry: Resilient**	**Total**
	19	**4**	**5**	**28**
Survey: Maintained	1	0	1	2
Survey: Increased	1	1	0	2
Total	**21**	**5**	**6**	**32**
Agreement: 19/32 (59.4%). Cohen's κ (binary: decline vs. not) = 0.10.				

Table 3
Discordant Sites (N = 13)

Site	Survey	Registry	All Δ%	Primary Δ%
Site U	Increased	Declined	−26.0	−32.6
Site O	Maintained	Declined	−19.6	−17.1
Site K	Increased	Stable	−4.4	−9.5
Site J	Declined	Stable	−4.3	−5.7
Site I	Declined	Stable	−1.2	−6.5
Site H	Declined	Stable	0.0	−5.3
Site G	Declined	Stable	+ 4.1	−1.1
Site F	Declined	Resilient	+ 8.6	+ 12.6
Site E	Maintained	Resilient	+ 13.0	+ 5.9
Site D	Declined	Resilient	+ 14.4	+ 11.1
Site C	Declined	Resilient	+ 18.4	+ 18.2
Site B	Declined	Resilient	+ 25.0	+ 25.8
Site A	Declined	Resilient	+ 105.4	+ 126.7

Δ% = pre/post percent change in annual volume. Sites are identified by letter codes assigned in order of registry volume change (Site A = largest increase); codes are consistent across the manuscript and Supplement.

Revision Buffering

Four sites classified as Stable using all-case volume shifted to Declined when only primary cases were considered: Site K (− 4.4% overall vs. −9.5% primary), Site I (− 1.2% vs. −6.5%), Site H (0.0% vs. −5.3%), and Site J (− 4.3% vs. −5.7%). Three of four had revision shares of 11–13%, indicating that revision volume was buffering the primary-case decline (eTable 4).

Bivariate Associations With Registry Outcome

GLP-1 prescribing status was the survey variable most strongly associated with registry volume change (Table 4). Programs not prescribing GLP-1 agonists had a median registry volume change of + 9.2% (IQR, − 7.5 to + 22.4), compared with − 21.6% (IQR, − 27.9 to − 5.3) among prescribers (Wilcoxon P = 0.033); the categorical association with resilience classification was not significant (Fisher's P = 0.148). Staffing change, PCP referral change, payer coverage reversals, integration model, standardized protocol, perceived impact, and program type were not significantly associated with registry outcome (all P ≥ 0.11; eTable 5). Use of EHR-based alerts showed a nominal association with resilience (Fisher's P = 0.037)

that should be interpreted cautiously given the number of comparisons performed. RYGB share was positively but not significantly correlated with volume decline (Spearman ρ = 0.35, P = 0.053).

Table 4
Bivariate Associations With Registry Volume Change

Variable	n	Median Δ% (IQR)	Fisher P	Wilcoxon P
GLP-1 prescribing			0.148	**0.033**
Yes	26	−21.6 (− 27.9, − 5.3)		
No	6	+ 9.2 (− 7.5, + 22.4)		
Staffing change			0.298	—
PCP referral change			0.214	—
Payer reversals			0.107	—
Integration model			0.269	—
Standardized protocol			0.378	0.579
Perceived impact			0.732	—
EHR-based alerts†			**0.037**	—
RYGB % (ρ = 0.35)‡	32	—	—	0.053

Boldface indicates P < 0.05. Δ% = registry pre/post percent change. IQR = interquartile range. EHR = electronic health record.

† Exploratory finding; should be interpreted cautiously given the number of bivariate comparisons performed.

‡ Tested by Spearman rank correlation of RYGB share with continuous percent change (P shown in final column).

Multivariable Analysis

In Firth penalized logistic regression, GLP-1 prescribing showed the strongest signal (Model 1 coefficient − 1.65, P = 0.118; Model 2 coefficient − 1.42, P = 0.156) but did not reach conventional significance (eTable 1). In a linear model of continuous percent change, GLP-1 prescribing was the only significant predictor (coefficient − 32.4, P = 0.044), although overall model fit was borderline (R^2 = 0.33; F-test P = 0.052).

Qualitative Findings

Open-ended survey responses revealed convergent themes among resilient programs (eTables 6–7). Four operational models were consistently described: (1) combined medical–surgical clinics with obesity medicine providers referring internally to surgery after GLP-1 non-response; (2) GLP-1 therapy positioned exclusively as a bridge to surgery or post-operative weight regain management; (3) dedicated

patient navigators with scheduling control; and (4) combined multidisciplinary seminars with formal stepped-care pathways. Programs reporting ineffective strategies consistently cited digital advertising, direct PCP outreach, and community health fairs as generating interest in medical weight management but not converting to surgical referrals.

DISCUSSION

In this statewide mixed-methods study of 32 bariatric surgery programs, we found three principal results. First, survey self-reported volume trajectory had near-zero concordance with registry-measured trajectory ($\kappa = 0.10$), and this was robust across threshold specifications and case-type definitions. Second, the GLP-1 era has disproportionately affected primary surgical candidates (44% decline) while largely sparing revision patients (18% decline). Third, no single survey-reported program characteristic was independently and robustly associated with resilience in multivariable analysis, although qualitative data identified convergent operational patterns among resilient programs.

The volume decline observed across programs parallels national trends. The ASMBS procedural volume assessment documented a nearly 25% decline in metabolic and bariatric surgery volume in the United States between 2022 and 2024, with substantial variation across states.[4] Our program-level analysis shows that this aggregate decline masks considerable heterogeneity even within a single state. Although Michigan programs share a common payer landscape, regulatory environment, and quality improvement infrastructure, two thirds of programs declined while nearly one in five grew over the same period. This degree of variation within a shared environment argues against a purely market-level explanation for volume loss and supports closer examination of program-level factors.

The poor concordance between self-report and registry is perhaps the most immediately actionable finding. Quality improvement collaboratives routinely rely on self-reported program assessments for benchmarking and performance improvement.[11,12] Our finding that 41% of sites misclassified their own volume direction calls this practice into question. The direction of misperception was not random: more sites underestimated their performance (5 said declined but actually improved) than overestimated (2), consistent with the pervasive negative narrative surrounding GLP-1 impact on bariatric surgery.[21] Programs may anchor their self-assessment to the broader narrative rather than to their own data, a cognitive bias well-documented in organizational performance assessment.[22]

These findings have direct implications for how collaboratives communicate with member programs. Because the registry already captures every bariatric case performed at participating sites, objective volume trajectories could be returned to programs routinely, for example through periodic site-level reports that separate primary from revision volume and benchmark each program against the collaborative. Such feedback would allow programs to recalibrate their perceptions, recognize primary-case erosion that is masked by stable revision volume, and target improvement efforts earlier. Collaborative quality improvement has historically depended on timely, audited data returned to sites,[11,12] and volume monitoring in the GLP-1 era may benefit from the same approach.

The primary-versus-revision decomposition adds a novel mechanism to prior reports of declining surgical volume.[4,6] Four sites that appeared Stable on total volume were actually Declining on primary cases, with revision volume buffering the loss. Programs with low revision share have less natural insulation against primary-case diversion. From a monitoring perspective, total case counts alone may give programs false reassurance; tracking primary and revision volume separately would provide an earlier signal of declining new-patient demand. The emergence of SIPS/SADI (2 cases in 2019 to 148 in 2025), concentrated at a small number of centers, further underscores the heterogeneity of program-level responses.[23]

The GLP-1 prescribing association warrants careful interpretation. Programs not prescribing GLP-1 medications showed significantly more favorable volume change on rank-based comparison, but this almost certainly reflects program-level confounding,[24,25] and the categorical association with resilience classification was not statistically significant. The six non-prescribing sites were heterogeneous, three were Resilient, one Stable, and two Declined, and the group's favorable median was driven largely by a single program launched in 2021 whose growth from a near-zero baseline (+ 105%) reflects startup dynamics rather than a treatment-strategy effect. National data similarly show that patients undergoing surgery are more medically complex than those treated with GLP-1 RAs, suggesting the therapies serve partly distinct populations.[7] Our survey data are consistent: the programs with the strongest qualitative resilience signals are GLP-1 prescribers operating integrated medical-surgical models. GLP-1 prescribing is more likely a marker of comprehensive obesity care engagement than a competing therapy.

The qualitative findings offer the most directly actionable content. Every program reporting maintained volume described some variant of integrated care with internal referral, bringing obesity medicine inside the bariatric practice and owning the patient journey.[26] Conversely, every program reporting failed strategies described externally directed efforts that did not convert to surgical referrals, consistent with the demand-side referral bottleneck (62% reporting PCPs less likely to refer). Resilience is structural, not tactical.

This study has several limitations. The ecological nature of site-level analyses precludes causal inference.[24,25] The small sample (N = 32) constrains statistical power. Two responding programs began performing bariatric surgery during the post-period and lacked pre-period volume for the pre/post comparison. The survey captures a single time point. Seven sites initiated but did not complete the survey, and nonresponding programs may differ systematically from respondents. Although the survey was intended to be completed jointly by the coordinator and lead surgeon, responses may reflect the perceptions of a single individual rather than the program as a whole, and the survey items have not been formally validated. Because the registry captures only patients who proceed to surgery, we cannot observe patients who were diverted to medical therapy, and program-level GLP-1 prescribing may therefore be associated with volume through pathways the registry cannot measure. Finally, all programs participate in a single statewide collaborative with a dominant commercial payer, which may limit generalizability to other states and practice environments. Two programs may have incomplete 2025

data entry, which could overstate their post-period decline. The number of bivariate comparisons performed at this sample size raises the possibility of chance findings, and nominally significant associations should be interpreted as exploratory. The planned semi-structured interviews with resilient programs will be reported separately.

CONCLUSION

Self-reported volume trajectory has near-zero concordance with registry measurement, and the GLP-1 era disproportionately affected primary surgical candidates while sparing revision patients. Registry-anchored objective measurement is essential for valid quality improvement benchmarking. Programs maintaining volume consistently describe integrated medical-surgical models with internal referral pathways, a structural feature that quality improvement collaboratives are well-positioned to disseminate. Routinely returning registry-based volume data to programs, with primary and revision cases reported separately, offers a practical first step toward aligning program perception with measured performance.

Abbreviations

GLP 1
glucagon
like peptide-1 receptor agonist. Data represent all bariatric procedures at Michigan Bariatric Surgery Collaborative sites. Primary procedures declined 44.4% from the 2022 peak. Revision procedures declined 17.9%. Dashed vertical line indicates GLP-1 era onset (2023).

Declarations

Author Contribution

Akram Irshaid: Conceptualization, methodology, investigation, writing (original draft), writing (review and editing), supervision, project administration.Matthew Bucala: Methodology, formal analysis, data curation, software, visualization, writing (original draft), writing (review and editing).Amanda Stricklen: Project administration, investigation, data curation, writing (review and editing).Oliver Varban: Writing (review and editing), supervision.Jonathan Finks: Writing (review and editing), supervision.Nabeel Obeid: Writing (review and editing), supervision.Mina Kia: Investigation, writing (review and editing).Rachel Ross: Project administration, data curation, writing (review and editing).Erin Charbeneau: Data curation, investigation, writing (review and editing).Hope Jackson: Writing (review and editing), supervision.Amir Ghaferi: Writing (review and editing), supervision.Arthur Carlin: Conceptualization, methodology, investigation, writing (original draft), writing (review and editing), supervision, project administration.

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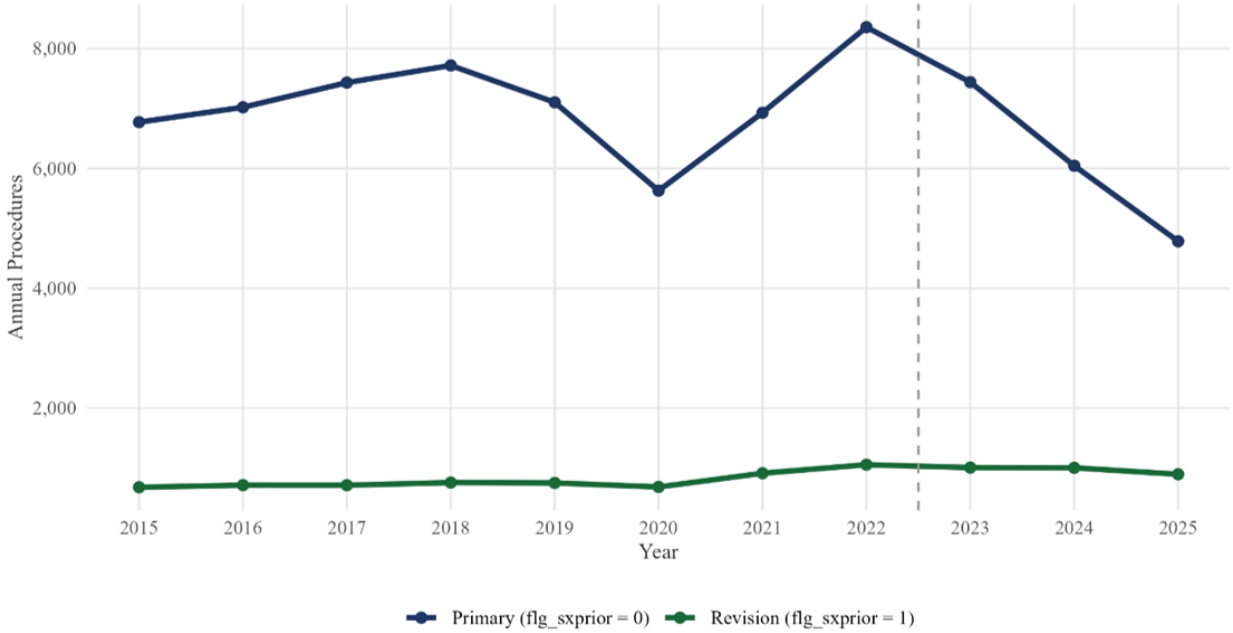
Figures

Figure 1. Primary vs. Revision Bariatric Surgery Volume, MBSC, 2015–2025

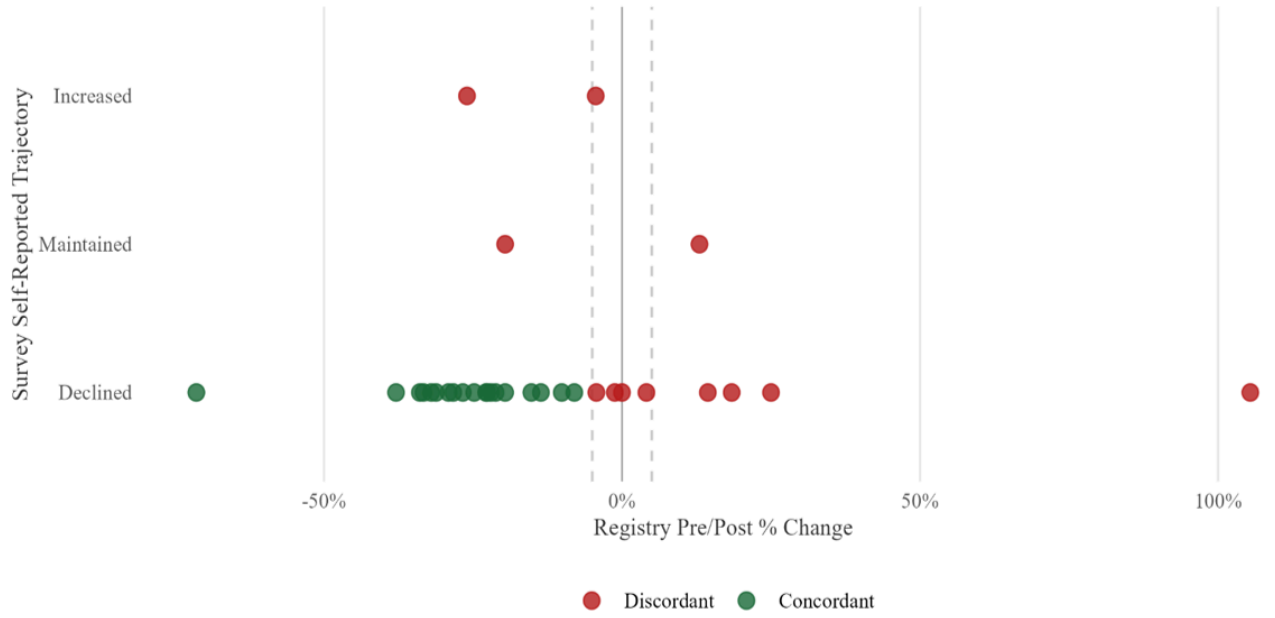


Abbreviations: GLP-1, glucagon-like peptide-1 receptor agonist. Data represent all bariatric procedures at Michigan Bariatric Surgery Collaborative sites. Primary procedures declined 44.4% from the 2022 peak. Revision procedures declined 17.9%. Dashed vertical line indicates GLP-1 era onset (2023).

Figure 1

See image above for figure legend

Figure 2. Survey Self-Report vs. Registry Volume Change



Notes: Pre-period: 2019, 2021, 2022 annual average; post-period: 2023–2025 annual average. Registry classification: Declined (>5% decrease), Stable (±5%), Resilient (>5% increase). Concordant sites (green circles) matched between survey self-report and registry classification; discordant sites (red crosses) did not. Raw agreement: 19/32 (59.4%). Cohen's κ = 0.10. See eTables 2–3 for sensitivity analyses across threshold specifications.

Figure 2

See image above for figure legend

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- GLP1Paper2SupplementvF.docx