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Robotic versus laparoscopic primary metabolic and bariatric surgery: a propensity score–matched analysis of the German StuDoQ/MBE registry

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Abstract

Background:

Real-world data on perioperative outcomes after robotic-assisted metabolic bariatric surgery (MBS) remain vastly heterogeneous. In this study, short-term perioperative outcomes of robotic-assisted and laparoscopic primary MBS were compared at the national level in Germany.

Methods:

Data from the national prospective German clinical quality registry (StuDoQ/MBE) were analyzed. Patients undergoing robotic-assisted or laparoscopic primary MBS between 2014 and 2025 were compared after 1:1 propensity score matching. Matching variables were age, sex, body mass index, ASA classification, Charlson Comorbidity Index, year of surgery, and procedure type. The primary endpoint was the occurrence of postoperative complications. Secondary endpoints include occurrence of major complications, mortality, operative time, and postoperative length of stay. Temporal trends were explored using mixed regression models.

Results:

138,696 laparoscopic and 3,930 robotic-assisted cases were included. After 1:1 propensity score matching, robotic-assisted and laparoscopic procedures were compared. Robotic-assisted surgery was associated with higher odds of overall postoperative complications (odds ratio [OR] 1.34, 95% CI (1.10;1.64); p = 0.0038). There were no statistically significant differences in the occurrence of major complications, while mortality was similarly rare in both cohorts. Operative times of robotic-assisted procedures were longer, with a mean difference of 27.14 minutes (95% CI (25.24;29.04); p < 0.0001). Postoperative length of stay was comparable between groups.

Conclusions:

Thus far, robotic-assisted primary MBS is not widely adopted in Germany. A higher risk of overall complications and a longer surgical duration, along with a steep reduction over time compared to the laparoscopic approach, denote ongoing learning curves. Of note, the occurrence of major complications, mortality risk, and postoperative length of stay were comparable during the early implementation phase.

Introduction

Metabolic and bariatric surgery (MBS) remains the most effective long-term treatment for severe obesity and obesity-related metabolic comorbidities and has been shown to improve quality of life and extend life expectancy (1;2). Minimally invasive approaches are the standard of care as they entail superior

safety profiles with reduced perioperative morbidity and mortality (3;4;5). Primary MBS has also been shown to be safe in accredited centers, with perioperative morbidity rates of approximately 7% and mortality rates of 0.1–0.3%, depending on procedure type and patient selection (6;7;8).

Robotic bariatric surgery has been introduced as a potential means of overcoming specific technical limitations of conventional laparoscopy. The robotic platform provides high-definition three-dimensional visualization, wristed instrumentation with enhanced dexterity, tremor filtration, motion scaling, and improved surgeon ergonomics (9;10;11;12). These potential advantages may be particularly relevant in patients with obesity, in whom increased abdominal wall thickness and visceral adiposity can aggravate the laparoscopic fulcrum effect and increase the force required for instrument manipulation (13;14). Robotic assistance may also be advantageous during technically demanding steps such as intracorporeal suturing, knot tying, and anastomosis construction, which are central components of gastric bypass procedures (9;15;16;17).

The number of bariatric surgery procedures has continued to increase over recent years, as demonstrated by large national registry analyses (18;19;20;21;22;23;24;25).

Existing evidence consistently reports longer operative times for robotic-assisted compared with laparoscopic procedures (18;25;26). Data regarding postoperative morbidity are heterogeneous and appear to be procedure-specific, with several large registry studies reporting higher rates of infectious complications, readmissions, or reoperations after robotic sleeve gastrectomy, whereas the robotic approach for revisional or more complex metabolic and bariatric procedures may yield advantages (25;27;28). Similarly, the impact of robotic surgery on postoperative length of hospital stay remains inconsistent across studies (20;29).

The present study aimed to evaluate the role of robotic-assisted primary metabolic and bariatric surgery in Germany using data from the prospectively collected national German clinical quality registry StuDoQ/MBE. Therefore, we compared perioperative outcomes of robotic-assisted and laparoscopic primary metabolic and bariatric surgery after propensity score matching, focusing on postoperative complications, operative time, postoperative length of stay, and temporal trends that may reflect implementation processes and learning-curve effects.

Methods

Study Design

An analysis of prospectively collected national data from the German Metabolic Bariatric Registry StuDoQ|MBE (DGAV) project number StuDoQ-2024-0004 was performed.

German metabolic bariatric surgery registry (StuDoQ/MBE)

The German Metabolic and Bariatric Surgery Registry, StuDoQ|MBE, is a nationwide clinical quality registry maintained by the Study, Documentation and Quality Center of the German Society for General and Visceral Surgery (DGAV). The registry prospectively collects standardized data from participating bariatric surgical centers in Germany and is used for quality assurance, certification, benchmarking, and clinical research.

StuDoQ|MBE includes information on patient demographics, obesity-related comorbidities, operative procedures, surgical access, perioperative outcomes, postoperative complications, and follow-up data. Data entry is performed by participating centers using predefined registry variables and standardized documentation procedures. Only cases with documented patient consent and validated datasets were included in the present analysis.

For the present study, StuDoQ|MBE was used to identify adult patients undergoing primary laparoscopic or robotic-assisted MBS between 2014 and 2025.

Ethics

The analysis was conducted using anonymized data from the national German StuDoQ|MBE registry. Access to registry data for scientific evaluation was granted by the DGAV in accordance with the registry governance framework. As only anonymized registry data were analyzed and no additional patient contact or intervention was performed, no separate informed consent for this study was required. Ethical approval for data collection and scientific use of registry data is covered by the registry governance procedures and participating centers obtain local approvals according to national regulations.

Data quality and validation

The StuDoQ|MBE registry is a prospective clinical quality registry with standardized electronic data collection. Data quality is ensured through predefined data fields, automated plausibility and completeness checks during data entry, regular quality-control procedures by the DGAV, and exclusion of records with critical documentation errors or missing key variables. Only validated datasets fulfilling registry quality standards were included in the present analysis.

Outcome definitions

The present study focused exclusively on perioperative outcomes and 30-day postoperative follow-up. Postoperative complications, major complications, mortality, operative time, and postoperative length of stay were analyzed as registry-defined perioperative outcomes occurring during the index hospitalization. Major complications were defined according to the Clavien–Dindo classification (grade ≥ 3).

Representativeness of the registry

The StuDoQ|MBE registry is the largest national bariatric surgery registry in Germany and serves as the mandatory quality-assurance platform for the DGAV-certified bariatric centers. During the study period, the registry included data from certified bariatric centers across Germany and is considered representative of contemporary bariatric surgical practice in certified German institutions.

Cohort selection, data extraction, and validation

Data extraction from the StuDoQ|MBE registry was performed in January 2026, and statistical analyses were completed in April 2026. Adult patients undergoing primary MBS between 2014 and 2025 were eligible for inclusion. The analysis was restricted to the three most commonly performed primary procedures: sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), and one-anastomosis gastric bypass (OAGB).

Patients were stratified according to surgical access into laparoscopic and robotic-assisted cohorts. Open procedures, single-incision laparoscopic surgery, procedures with mixed or undocumented access, and secondary or revisional bariatric procedures were excluded. Cases with missing data in variables required for propensity score matching or outcome analysis were also excluded from the analysis. Propensity score matching was then performed to generate comparable robotic-assisted and laparoscopic cohorts for the primary analysis.

Outcome variables

The primary outcome was postoperative morbidity after primary MBS. Overall, postoperative complications were defined as any documented postoperative adverse event recorded within the registry-defined perioperative observation period. Major complications were defined as complications classified as Clavien-Dindo grade ≥ 3. Mortality was analyzed separately. Secondary outcomes included operative time and postoperative length of hospital stay.

In addition, temporal trends in operative time, postoperative length of stay, and postoperative complication risk were analyzed. These analyses were performed to evaluate changes over time and to assess whether temporal patterns differed between robotic-assisted and laparoscopic surgery, potentially reflecting implementation and learning-curve effects.

Statistical Analysis

Propensity score matching was performed between patients undergoing robotic-assisted and laparoscopic metabolic/bariatric surgery. Matching variables included age, sex, preoperative body mass index (BMI), ASA classification, Charlson Comorbidity Index, type of bariatric procedure, and year of surgery. The propensity score was estimated using a logistic regression model including all predefined

matching variables as covariates, followed by 1:1 matching. A caliper width of 0.2 standard deviations of the logit-transformed propensity score was used to identify the best matching partners. The balance of baseline covariates was determined based on z-differences where absolute z-differences of $\geq \sqrt{2} (\geq 1.41)$ are considered indicative of imbalance. For the analysis of the primary endpoint and binary secondary outcomes, stratified logistic regression models were used with matching stratum as strata variable. For continuous secondary outcomes, linear mixed regression models with a random intercept for the matching stratum were applied. Estimated regression coefficients and odds ratios are reported with their corresponding 95% confidence intervals (95% CI) and p-values, if appropriate. To further evaluate potential time trends, additional regression models including surgical approach, year of surgery and an interaction term between surgical approach and year of surgery as covariates and the matching stratum as strata variable or random intercept were applied. These models were used to assess whether changes in operative time, postoperative length of stay, and complication risk differed between robotic-assisted and laparoscopic surgery over time. Model-based predicted values were calculated for each surgical approach by year of surgery and displayed graphically. All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC) and R version 4.6.0.

Results

Between 2014 and 2025 (Fig. 1), a total of 149.492 MBS cases were documented in the prospectively collected national German StuDoQ/MBE registry. After all inclusion and exclusion criteria were applied, a total of 142,626 patients were eligible for further analysis.

Propensity Score Matching

The final pre-matching cohort included 142.626 patients, comprising 138.696 (97.25%) laparoscopic and 3.930 (2.75%) robotic procedures. After 1:1 propensity score matching, 3.930 robotic cases could be matched to 3.930 laparoscopic cases.

Prior to matching, the two cohorts differed substantially in several baseline characteristics. Patients undergoing robotic surgery were younger, had lower BMI, lower ASA scores, and were treated in more recent years compared with the laparoscopic cohort. Furthermore, the distribution of bariatric procedures differed between groups, with robotic surgery used more frequently for Roux-en-Y gastric bypass, whereas sleeve gastrectomy was more commonly performed laparoscopically.

Balance diagnostics showed a substantial improvement in covariate distribution after matching, with absolute z-differences below 1.41 for most included variables, indicating excellent comparability between the robotic-assisted and laparoscopic groups. Table 1 presents the descriptive baseline characteristics before and after propensity score matching.

Table 1
Baseline characteristics before and after propensity score matching

Pre-Matching			
Covariate	Robotic (n = 3930)	Laparoscopic (n = 138696)	z-Difference
Sex (male)	1000 (25.45%)	38098 (27.47%)	-2.87
Age (years)	42.53 (11.41)	43.00 (11.73)	-2.53
BMI	46.83 (6.83)	48.17 (7.60)	-12.10
OP date	2023.04 (1.98)	2021.29 (2.63)	54.17
ASA			-21.80
< 3	2236 (56.90%)	53247 (38.39%)	
≥ 3	1694 (42.78%)	85449 (61.61%)	
Charlson score	0.41 (0.70)	0.47 (0.75)	-4.53
Operation technique			NA
RYGB	2294 (58.37%)	41982 (30.27%)	
OAGB	291 (7.40%)	15963 (11.51%)	
SG	1345 (34.22%)	80751 (58.22%)	
Post-Matching			
	Robotic (n = 3930)	Laparoscopic (n = 3930)	z-Difference
Sex (male)	1000 (25.45%)	954 (24.27%)	1.20
Age (years)	42.53 (11.41)	42.43 (11.35)	0.40
BMI	46.83 (6.83)	46.84 (7.18)	-0.04
OP date	2023.04 (1.98)	2023.05 (1.90)	-0.17
ASA			0.27
< 3	2236 (56.90%)	2248 (57.20%)	
≥ 3	1694 (43.10%)	1682 (42.80%)	
Charlson score	0.41 (0.70)	0.41 (0.69)	0.05
Operation technique			-1.79
RYGB	2294 (58.37%)	2282 (58.07%)	
OAGB	291 (7.40%)	293 (7.46%)	
SG	1345 (34.22%)	1355 (34.48%)	

After matching, robotic surgery was associated with modest but higher odds of overall complications compared to laparoscopic surgery (6.11% vs. 4.63%, OR: 1.34, 95%-CI (1.10; 1.64), p = 0.0038) (Table 2). There was no evidence for a difference in the odds of major complications between the surgical approaches (3.66% vs. 3.18%, OR: 1.16, 95%-CI (0.91; 1.49), p = 0.2345). Mortality was rare (0.05%) and thus assessed only descriptively.

Robotic surgery required longer operative times across all procedure types. Overall operative time averaged 112.04 (SD: 49.30) minutes in the robotic compared with approximately 84.90 minutes (SD: 37.54) in the laparoscopic group. The mixed regression model confirmed that robotic surgery prolonged operative duration by approximately 27.14 minutes (95% CI: (24.24; 29.04), p < 0.0001) on average.

Postoperative length of stay did not differ statistically significantly between groups (3.51 (SD: 3.56) vs. 3.51 (SD: 4.09), mean difference 0.01, 95%-CI (-0.16; 0.18), p = 0.9364). Furthermore, postoperative stay decreased steadily over time in both groups (Table 3).

Table 2
Primary and secondary endpoints before and after matching

Pre-Matching			
	Robotic (n = 3930)	**Laparoscopic (n = 138696)**	**Total (n = 142626)**
Complication (Yes)	240 (6.11%)	6451 (4.65%)	7218 (5.06%)
Major Complication (Yes)	144 (3.66%)	4080 (2.94%)	4224 (2.96%)
Clavien-Dindo:			
No Complication	3690 (93.89%)	132245 (95.35%)	142274 (99.75%)
Grade 1	55 (1.40%)	1206 (0.87%)	1325 (0.93%)
Grade 2	41 (1.04%)	1165 (0.84%)	1278 (0.90%)
Grade 3a	44 (1.12%)	1113 (0.80%)	1258 (0.88%)
Grade 3b	81 (2.06%)	2436 (1.76%)	2757 (1.93%)
Grade 4a + 4b	17 (0.43%)	424 (0.31%)	483 (0.34%)
Death	2 (0.05%)	107 (0.08%)	117 (0.08%)
Operative time (minutes (SD))			
Overall	112.04 (49.30)	78.68 (37.95)	79.60 (38.69)
RYGB	127.15 (48.91)	101.47 (39.82)	102.80 (40.74)
OAGB	106.99 (44.04)	83.79 (35.59)	84.20 (35.89)
SG	87.35 (40.00)	65.82 (30.95)	66.17 (31.23)
Postoperative stay (days (SD))	3.51 (3.56)	3.93 (4.68)	3.92 (4.55)
Post-Matching			
	Robotic (n = 3930)	Laparoscopic (n = 3930)	Total (n = 7860)
Complication (Yes)	240 (6.11%)	182 (4.63%)	422 (5.37%)
Major Complication (Yes)	144 (3.66%)	125 (3.18%)	269 (3.42%)
Clavien-Dindo:			
No Complications	3690 (93.89%)	3748 (95.37%)	7438 (94.63%)
Grade 1	55 (1.40%)	29 (0.74%)	84 (1.07%)

Pre-Matching			
	Robotic (n = 3930)	**Laparoscopic (n = 138696)**	**Total (n = 142626)**
Grade 2	41 (1.04%)	28 (0.71%)	69 (0.88%)
Grade 3a	44 (1.12%)	37 (0.94%)	81 (1.03%)
Grade 3b	81 (2.06%)	74 (1.88%)	155 (1.97%)
Grade 4a + 4b	17 (0.43%)	12 (0.31%)	29 (0.37%)
Death	2 (0.05%)	2 (0.05%)	4 (0.05%)
Operative time (minutes (SD))			
Overall	112.04 (49.30)	84.90 (37.54)	98.47 (45.87)
RYGB	127.15 (48.91)	98.50 (36.62)	112.86 (45.53)
OAGB	106.99 (44.04)	78.65 (37.02)	92.77 (43.04)
SG	87.35 (40.00)	63.34 (27.36)	75.30 (36.29)
Postoperative stay (days (SD))	3.51 (3.56)	3.51 (4.09)	3.51 (3.83)

Table 3
Results from statistical analysis of primary and secondary endpoints

Complication (yes vs. no)			
Covariate	Odds Ratio	95%-CI	p-value
Robotic vs. laparoscopic	1.34	[1.10; 1.64]	0.0038
Major Complication (yes vs. no)			
Covariate	Odds Ratio	95%-CI	p-value
Robotic vs. laparoscopic	1.16	[0.91; 1.49]	0.2345
Operative time (minutes)			
Covariate	Mean difference	95%-CI	p-value
Robotic vs. laparoscopic	27.14	[25.24; 29.04]	< 0.0001
Postoperative stay (days)			
Covariate	Mean difference	95%-CI	p-value
Robotic vs. laparoscopic	0.01	[-0.16; 0.18]	0.9364

Assessment of time trends

Operative time

Linear mixed regression models with interaction terms demonstrated an association between surgical approach, year of surgery, and operative time. In the interaction model, robotic surgery was associated with a substantially longer operative duration compared with laparoscopic surgery. The regression coefficient for robotic versus laparoscopic surgery was 50.32 minutes (95% CI (40.39; 60.25), $p < 0.0001$), indicating that robotic procedures were initially considerably longer than laparoscopic procedures. Across the study period, operative time decreased substantially overall. Each additional calendar year was associated with a reduction in operative time of 2.39 minutes (95% CI (− 3.10; −1.68), $p < 0.0001$). The estimated coefficient for the interaction term was − 2.31 minutes per year (95% CI (− 3.28; −1.34), $p < 0.0001$), demonstrating that operative time decreased more rapidly in the robotic group than in the laparoscopic group (Supplementary Table 1).

For laparoscopic surgery, predicted operative time decreased from 106.54 minutes (95% CI: (99.96; 113.13)) in 2014 to 80.24 minutes (95% CI: (78.30; 82.17)) in 2025. In comparison, robotic surgery showed a larger absolute reduction, decreasing from 154.55 minutes (95% CI: (148.23; 160.87)) in 2014 to 102.84 minutes (95% CI: (100.93; 104.74)) in 2025. Although robotic procedures remained longer than laparoscopic procedures throughout the study period, the difference between the two approaches narrowed substantially over time. (Supplementary Table 2, Supplementary Fig. 1)

Postoperative stay

Linear mixed regression models with interaction terms showed no statistically significant difference in postoperative length of stay between robotic and laparoscopic surgery. The regression coefficient for robotic versus laparoscopic surgery was 0.05 days (95% CI (− 0.84; 0.94), $p = 0.920$). In contrast, the year of surgery was significantly associated with postoperative length of stay. Each additional year was associated with a reduction of 0.21 days in postoperative length of stay (95% CI (− 0.28; −0.15), $p < 0.0001$). The temporal reduction in postoperative stay was comparable between robotic and laparoscopic procedures. (Supplementary Table 3)

In the laparoscopic group, postoperative stay decreased from 5.43 days (95% CI: (4.85; 6.01)) in 2014 to 3.09 days (95% CI: (2.92; 3.26)) in 2025. In the robotic group, the predicted stay decreased almost identically from 5.47 days (95% CI: (4.91; 6.03)) in 2014 to 3.09 days (95% CI: (2.92; 3.26)) in 2025 (Supplementary Table 4, Supplementary Fig. 2).

Postoperative complications

Results from the logistic regression model, including interaction terms, indicated that there was no evidence for an association between the surgical approach and the occurrence of postoperative complications (OR 0.61; 95% CI (0.24; 1.57); $p = 0.3055$). The year of surgery was significantly associated with postoperative complications. In the laparoscopic group, the odds of postoperative complications

decreased with each subsequent year of surgery (OR 0.89 per year; 95% CI (0.83; 0.95); p = 0.00108). (Supplementary Table 5)

In the laparoscopic group, the predicted probability of postoperative complications decreased from 12% (95% CI: (11; 13)) in 2014 to 4% (95% CI: (4; 4)) in 2025. In contrast, the robotic group showed a more stable trend, with predicted probabilities decreasing only slightly from 8% (95% CI: (8; 9)) in 2014 to 6% (95% CI: (6; 6)) in 2025. While the laparoscopic group had a higher predicted complication probability at the beginning of the observation period, the probabilities converged over time and were numerically lower than those in the robotic group in later years. (Supplementary Table 6, Supplementary Fig. 3)

Discussion

In Germany, bariatric surgery has historically been underutilized despite a relatively high prevalence of obesity, although procedure volumes and specialized centers have increased over time (30;31). Previous German registry analyses have demonstrated low perioperative morbidity and mortality after bariatric surgery (32;33).

Robotic platforms offer potential technical and ergonomic advantages during complex minimally invasive surgery, including improved visualization, enhanced dexterity, and improved surgeon ergonomics (34;35).

The low adoption rate of robotic-assisted primary MBS in the present study suggests that robotic bariatric surgery remains in an early implementation phase in Germany compared with conventional laparoscopy. In the present cohort, robotic surgery was used more frequently for Roux-en-Y gastric bypass than for sleeve gastrectomy, which may reflect a perceived technical advantage of the robotic platform during more complex reconstructive procedures. However, this interpretation remains speculative, because the registry does not capture surgeon preference, technical rationale, or case complexity in sufficient detail.

In this national registry-based propensity score–matched analysis, robotic-assisted primary metabolic and bariatric surgery accounted for only a small proportion of procedures performed in Germany between 2014 and 2025. Compared with laparoscopic surgery, robotic-assisted surgery was associated with longer operative times and higher overall postoperative morbidity. However, major complications, mortality, and postoperative length of stay were comparable between groups. Operative times decreased over time in both groups, with a steeper decline in the robotic cohort, suggesting improving efficiency during the implementation phase of robotic bariatric surgery.

Minimally invasive metabolic and bariatric surgery is well established and can be performed safely in experienced centers, with low perioperative morbidity and mortality (1;36;8). The present findings add national real-world data from Germany to the growing literature evaluating whether the technical advantages of robotic surgery translate into measurable clinical benefit in primary bariatric procedures.

Previous large registry studies have consistently shown that robotic-assisted primary bariatric surgery is associated with longer operative times compared with conventional laparoscopy (18;20;25;26;27). The impact of robotic surgery on postoperative morbidity has been less consistent. Several studies have reported higher rates of complications, readmissions, reoperations, or infectious events after robotic procedures, particularly in primary sleeve gastrectomy, whereas outcomes after robotic Roux-en-Y gastric bypass appear more heterogeneous and may be more favorable in selected or complex cases (27;28;29). The findings of the present study are consistent with this pattern: robotic-assisted surgery was associated with higher overall morbidity, but no statistically significant difference in major complications or mortality.

The higher cost of robotic surgery remains an important consideration. Robotic platforms are associated with higher acquisition, maintenance, and procedure-related costs compared with conventional laparoscopic systems (37;38;39;40). Therefore, broader implementation in primary MBS should be justified by measurable clinical benefit, particularly in healthcare systems with limited resources. Based on the present findings, routine robotic use for all primary bariatric procedures is not supported.

Evidence from other surgical fields also suggests that the benefit of robotic technology is procedure-specific. Randomized trials in inguinal and ventral hernia repair have not demonstrated clear short-term clinical superiority of robotic surgery over laparoscopy, despite longer operative times and higher costs (41;42). Conversely, data from randomized trials from complex rectal cancer surgery suggest that robotic technology may improve selected technical and perioperative outcomes in more demanding procedures (43). These findings support the concept that robotic assistance may be most valuable when procedural complexity allows its technical advantages to matter clinically.

The longer operative times observed in the robotic cohort likely reflect both platform-related workflow and implementation effects. Docking, setup, system positioning, and instrument exchanges add time, particularly during the early phase of robotic program development (44;45;46). In highly standardized primary procedures, especially sleeve gastrectomy, these added steps may outweigh the technical benefits of the robotic platform. This may explain why longer operative time remains one of the most consistent findings across robotic bariatric studies.

Postoperative length of stay did not differ statistically significantly between groups. This finding is consistent with the heterogeneous literature, in which some studies report similar or longer hospitalization after robotic procedures, while selected subgroup analyses suggest earlier discharge in specific populations (47). Length of stay is likely influenced more strongly by institutional pathways, discharge criteria, reimbursement structures, and enhanced recovery protocols than by surgical platform alone.

The steeper decline in robotic operative time over the study period suggests progressive optimization of robotic workflows during the implementation phase, consistent with the broader concept that learning curves are important in minimally invasive bariatric surgery (48;49;50;51). Outcomes in bariatric surgery

are influenced not only by surgical platform but also by surgeon experience, technical proficiency, procedural volume, team familiarity, and institutional workflow (52;53).

Several limitations should be acknowledged. First, this was an observational registry-based study, and residual confounding cannot be excluded despite propensity score matching. Second, the registry does not provide detailed surgeon- or center-level information regarding robotic experience, annual robotic volume, platform generation, docking time, console time, operative technique, or team training. Third, the robotic cohort likely represents a heterogeneous group, including variability in robotic utilization, institutional implementation, and perioperative pathways. Fourth, registry-based outcomes may be influenced by center-level differences in documentation and reporting. Finally, the analysis was limited to short-term perioperative outcomes and did not include long-term weight loss, metabolic outcomes, quality of life, revisional surgery, or cost-effectiveness.

Conclusion:

In summary, robotic-assisted primary metabolic and bariatric surgery in Germany was associated with longer operative times and higher overall postoperative morbidity compared with laparoscopy, while major complications, mortality, and postoperative length of stay were comparable. The steeper reduction in operative time suggests improving efficiency over time. These findings do not support routine superiority of robotic assistance in primary MBS, but rather support selective, structured, and procedure-specific use of robotic platforms.

Declarations

Conflict of Interest:

None

Funding:

None

Author Contribution

Author Contributions:Idea and conceptualization: MV, FSData Collection: MV, FS, CKData Analysis: MV, AH, AD, CKWriting the Manuscript: MV, FSRevising and Editing the Manuscript: MV, FSFinal Approval: MV, FS, AH, AD, JH, SF, CK, ZM

Data Availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

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Figures

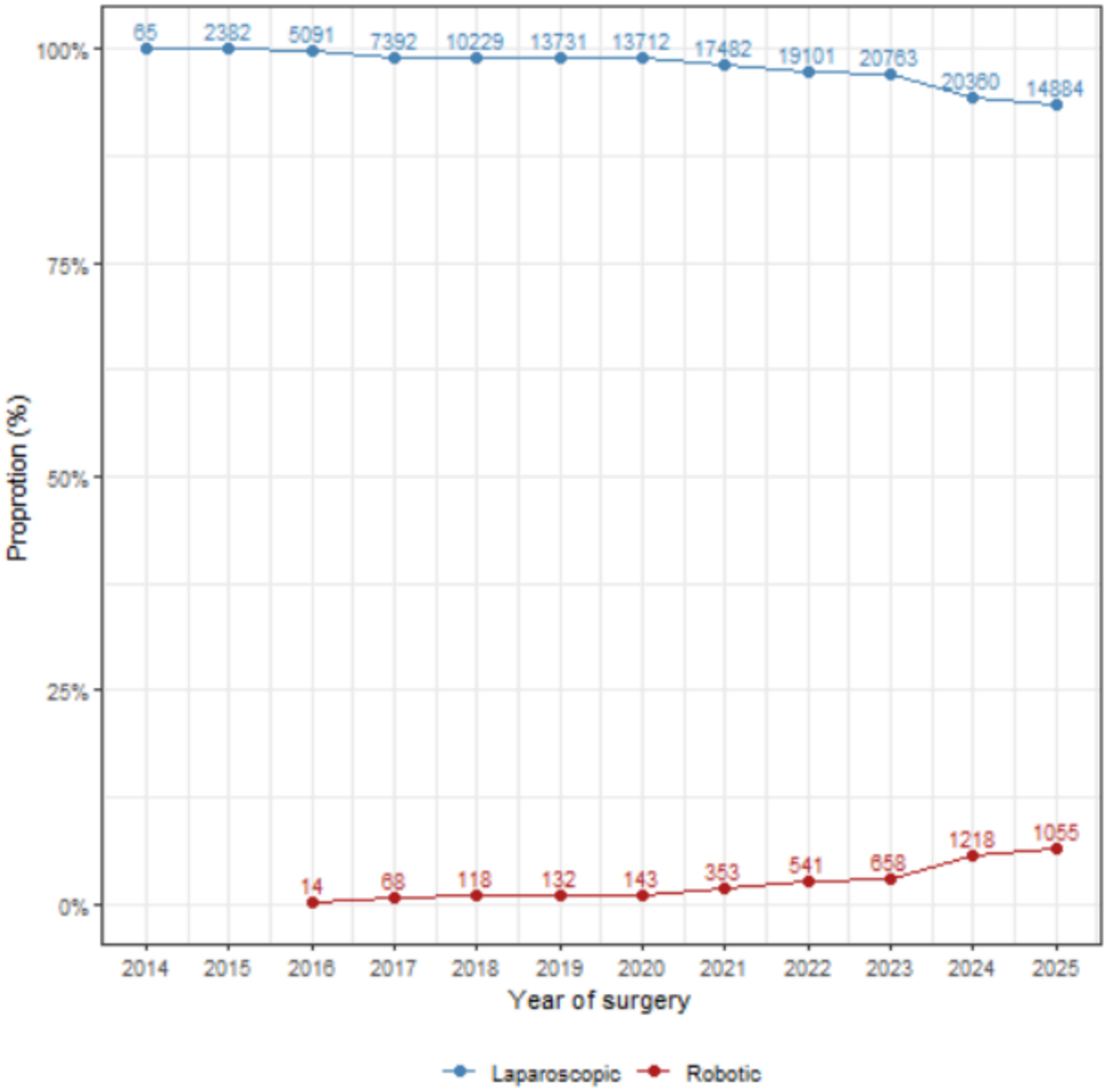


Figure 1

Number and proportion of all MBS between 2014 and 2025

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