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Bariatric surgery prior to transplantation and risk of early hospital re-admission, graft failure, or death following kidney transplantation

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Abstract

Bariatric surgery has been shown to be safe in the dialysis population. Whether bariatric surgery before kidney transplantation influences posttransplant outcomes has not been examined nationally. We included severely obese (BMI >35) dialysis patients between 18 and 70 years who received a kidney transplant according to the US Renal Data System. We determined the association between history of bariatric surgery and risk of 30-day readmission, graft failure, or death after transplantation using multivariable logistic, Fine-Gray, and Cox models. We included 12 573 patients, of whom 503 (4%) received bariatric surgery before transplantation. Median age at transplant was 53 years; 42% were women. Overall, history of bariatric surgery was not statistically significantly associated with graft failure (HR 1.02; 95% CI 0.77–1.35) or death (HR 1.10; 95% CI 0.84–1.45). However, sleeve gastrectomy (vs. no bariatric surgery) was associated with lower risk of graft failure (HR 0.39; 95% CI 0.16–0.95). In conclusion, history of bariatric surgery prior to kidney transplantation was not associated with allograft or patient survival, but findings varied by surgery type. Sleeve gastrectomy was associated with better graft survival and should be considered in severely obese transplant candidates receiving dialysis.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section.

Keywords

health services and outcomes research; kidney failure/injury; kidney transplantation/nephrology; obesity

1 | INTRODUCTION

Although obesity is a known risk factor for morbidity in the general population, there has been significant controversy over the optimal weight for patients with end-stage kidney disease (ESKD).[1–6] Weight loss prior to kidney transplantation could potentially reduce the risk of postoperative complications and delayed graft function, and improve survival.[7–9] However, for many dialysis patients, weight loss is challenging to achieve.[7–9] With advances in bariatric surgery techniques, there has been an increase in bariatric surgery rates among Medicare patients with ESKD.[10] Recent studies have demonstrated a strong association between bariatric surgery and improved access to kidney transplantation in severely obese dialysis patients.[11,12]

The objective of this study was to determine whether performance of bariatric surgery prior to transplantation in severely obese patients receiving dialysis is associated with benefits after transplantation, either for the allograft or patient. We hypothesized that dialysis patients who underwent bariatric surgery prior to transplantation would have improved graft and patient survival without a higher risk of 30-day readmissions compared to those who did not undergo bariatric surgery prior to kidney transplantation.

2 | METHODS

2.1 | Study population

The target population included severely obese patients who underwent kidney transplantation, with or without the receipt of bariatric surgery while being treated with dialysis. We included adults between 18 and 70 years who started dialysis between January 1, 2003 and December 31, 2016 with Medicare coverage at the time of dialysis initiation (or within one year of dialysis initiation) according to the United States Renal Data System (USRDS), the national ESKD registry (Figure 1).[13] To ascertain Medicare eligibility, we used the PAYHIST file and cross-referenced Medicare claims data to confirm claims for dialysis treatments. Medicare eligibility was required in order to ensure that receipt of bariatric surgery would be captured using claims. We only included patients who had a body mass index (BMI) >35 kg/m^2 at the time of dialysis initiation based on the MEDEVID form. We excluded patients who received bariatric surgery after transplantation (N = 340) or before dialysis initiation (N = 186, Figure 1). We determined transplant dates and donor source (living vs. deceased) using the Patient and Transplant files, which contain data from the United Network for Organ Sharing (UNOS). Details surrounding cohort derivation are in Figure 1.

We extracted demographic characteristics and patient zip codes using the Patient file and co-morbidity data from the MEDEVID forms, and time-updated the data using the MEDEVID form submitted at the time of kidney transplantation. To account for potential differences in organ source (living vs. deceased donor) and quality (Kidney Donor Profile Index [KDPI]),[14] we generated a four-category variable (henceforth termed organ quality) as a covariate (KDPI 0 to <35%, 35%–85%, ≥85%, or living donor).

2.2 | Propensity for bariatric surgery

We identified patients who received bariatric surgery using International Classification of Disease, Ninth and Tenth Revision, Clinical Modification (ICD-9 and ICD-10 CM) and Healthcare Common Procedure Coding System (HCPCS) codes for laparoscopic sleeve gastrectomy, all Roux-en-Y gastric bypass procedures, and laparoscopic gastric banding procedures (Table S1). We excluded patients who received a duodenal switch given there were only two patients who underwent this procedure (Figure 1). We extracted data from a number of data sources including the Medicare Hospitalization, Physician/Supplier, and Institutional Outpatient Claims files in the USRDS (see Table S1). We then constructed a propensity score for the likelihood of receiving bariatric surgery based on age at dialysis initiation, sex, race/ethnicity, median neighborhood income, insurance status, dialysis modality (peritoneal or hemodialysis), US census region, calendar year, BMI, and comorbidities at dialysis initiation.[15]

2.3 | Outcomes

We determined transplant dates (TX1DATE), transplant failure dates (TX1FAIL), donor source (living vs. deceased) for the first transplant event, and death dates using USRDS Patient and Transplant files.

We ascertained 30-day rehospitalization following discharge from the index hospitalization when transplantation occurred based on Medicare claims. If we could not identify the transplant-related hospitalization ($N = 316$) or patients no longer had Medicare at time of transplantation even though they qualified for entry into our cohort as a Medicare beneficiary while receiving dialysis ($N = 1653$), we excluded these patients from the evaluation of 30-day rehospitalization (Figure 1). We ascertained outcomes through December 31, 2017.

As a secondary outcome, we also determined the risk of acute rejection within the first year of transplant using the Transplant file.

2.4 | Statistical analysis

We examined the characteristics of patients included in the overall cohort and determined differences in characteristics between those who had a history of receiving bariatric surgery versus those who did not using chi-square, *t*-tests, or Kruskal-Wallis tests as appropriate (Table 1).

We examined the reasons for re-admission by bariatric surgery status and tested for differences in categories using chi-square. We then used logistic models to examine the relation between history of bariatric surgery and odds of 30-day rehospitalization, adjusted for each individual's propensity to receive bariatric surgery and donor organ quality (Model 1). We then additionally adjusted for BMI at transplant (in order to determine whether bariatric surgery continued to be associated with the odds of 30-day rehospitalization after accounting for BMI at transplantation, Model 2). We considered Model 2 our primary model.

Next, we used Fine and Gray models to examine the association between bariatric surgery and risk of graft failure, treating death as a competing risk and adjusting for the same covariates as above (Models 1–2). We used Cox models to examine the association between bariatric surgery and risk of death.

In secondary analysis, we also examined the odds of acute rejection in the first year posttransplant by bariatric surgery status.

In order to understand the relationship between type of bariatric surgery and posttransplant outcomes, we performed stratified analysis by type of bariatric surgery (categorized as Roux-en-Y, laparoscopic gastric banding, or sleeve gastrectomy).

In an alternative strategy, we used a propensity-score matched approach to conduct our analysis. We matched 3 controls to 1 patient who had a history of bariatric surgery using the propensity scores we generated previously and compared the characteristics of cases to controls to ensure balance in the characteristics of this matched cohort. We then repeated all models (logistic, Cox, Fine, and Gray) using this matched cohort, adjusted for organ quality (Model 1) and additionally, BMI at transplantation (Model 2).

All analyses were conducted in SAS 9.0 (SAS Institute). The University of California San Francisco considers this study exempt from human subjects research.

3 | RESULTS

3.1 | Cohort characteristics and outcomes

We included a total of 12 753 individuals who were severely obese at the time of dialysis initiation and who subsequently underwent kidney transplantation. The median age of the cohort was 48.7 years, 42% were women, 39% were of Black race, and 13% were of Hispanic ethnicity. A total of 503 bariatric surgery procedures occurred prior to kidney transplantation (4%). Of the procedures that occurred, 38.6% were Roux-en-Y procedures, 37.8% were sleeve gastrectomy, and 23.7% were laparoscopic band procedures. The median time between bariatric surgery and receipt of kidney transplant was approximately 2.05 years [IQR 1.13–3.39 years].

Compared to individuals who did not undergo bariatric surgery, those who underwent bariatric surgery tended to be younger, were more likely to be women, non-Hispanic Black or Hispanic, had higher BMI at dialysis initiation, and had a history of diabetes (Table 1). At the time of transplant, the median BMI was statistically significantly lower in those who had undergone bariatric surgery (33.3 ± 4.8 kg/m^2) compared with those who had not (34.4 ± 4.6 kg/m^2). There was no statistically significant difference in the proportion of individuals receiving deceased donor transplantation by history of bariatric surgery (Table 1).

Patients who underwent sleeve gastrectomy tended to be older than those who underwent Roux-en-Y or laparoscopic gastric banding (Table S2). Patients with diabetes were also more likely to undergo Roux-en-Y. The BMI at transplant was lowest for those who received a Roux-en-Y procedure and highest for those who had undergone laparoscopic banding.

In our alternative strategy in which we created a propensity-matched cohort ($N = 1960$), the characteristics of individuals with and without a history of bariatric surgery were overall balanced (Table S3A). However, age and BMI at transplant were statistically significantly different in those with a history of bariatric surgery (Table S3A,B). Patients who did not undergo bariatric surgery but received kidney transplantation had higher BMI than those who received bariatric surgery and were transplanted.

3.2 | Association of bariatric surgery with 30-day rehospitalization following kidney transplantation

A total of 3229 rehospitalizations occurred (30%) within 30 days of discharge from the index hospitalization when transplant surgery occurred. Approximately 34% of patients with a history of bariatric surgery required re-admission, whereas 30.3% without a history of bariatric surgery required re-admission within 30 days of discharge from the index hospitalization. There was a tendency toward more surgical-related complications leading to a readmission within 30 days in those receiving bariatric surgery versus not, but this did not achieve statistical significance (Table S4). The frequency of infection-related and gastrointestinal complications did not differ by bariatric surgery status (Table S4).

By type of bariatric surgery, the median change in BMI was 13.7 kg/m^2 [IQR 9.7–18.7 kg/m^2] in those who underwent Roux-en-Y, 9.8 kg/m^2 in those who underwent sleeve gastrectomy [IQR 5.6–14.1 kg/m^2], and 7.3 kg/m^2 [IQR 3.3–12.8 kg/m^2] in those who underwent laparoscopic banding. When we examined the association between bariatric surgery and odds of 30-day rehospitalization, we found that there was a higher odds of 30-day rehospitalization (OR 1.23; 95% CI 1.001–1.52, Table 2) in those with a history of bariatric surgery compared with those without, but this finding had borderline statistical significance and was not consistent across all models.

In particular, receipt of a Roux-en-Y procedure tended to be associated with higher odds of 30-day re-hospitalization in our primary model, though findings were not consistent across all models. Gastric banding also associated with a tendency toward higher risk of 30-day rehospitalization, although this finding did not achieve statistical significance (Model 2). Sleeve gastrectomy was not statistically significantly associated with odds of 30-day re-hospitalization.

3.3 | Association of bariatric surgery with graft failure and death

Graft failure occurred in 14.6% ($N = 1863$) of patients. In the subset of transplant recipients with a history of bariatric surgery, 10.5% ($N = 53$) experienced graft failure. When we examined the association between bariatric surgery and risk of graft failure, we found that overall, there was no statistically significant difference in the risk of graft failure comparing those with and without a history of bariatric surgery in adjusted Fine-Gray models (Models 1 and 2, Table 2).

However, in stratified analysis by type of bariatric surgery, we did find that those who received sleeve gastrectomy had lower risk of graft failure compared to those who did not undergo bariatric surgery. Laparoscopic banding was associated with a higher tendency for graft failure that did not achieve statistical significance. Roux-en-Y was not associated with risk of graft failure (Table 3).

A total of 2300 deaths occurred (including deaths following graft failure) in the overall cohort during a median follow-up of 3.8 years [IQR 1.8–6.5], and 70% ($N = 1603$) of deaths occurred in patients with a functioning allograft. When we examined the association between bariatric surgery and risk of death, we found that there was no statistically significant difference in the adjusted risk of death (Model 1 or Model 2) as shown in Table 2. Overall, there was also no statistically significant association between any specific type of bariatric surgery and risk of death (Table 3).

3.4 | Association between bariatric surgery and acute rejection

The odds of acute rejection within the first year after kidney transplant tended to be higher (OR 1.14; 95% CI 0.87–1.48) among those who received bariatric surgery compared to those who did not but the difference was not statistically significant, even after additional adjustment for BMI in Model 2 (OR 1.14; 95% CI 0.88–1.49).

3.5 | Sensitivity analysis using a propensity-matched cohort

In our alternative approach using a propensity-matched cohort, results were similar to those seen in analysis of the overall cohort. The risk of a 30-day rehospitalization among those with a history of bariatric surgery tended to be higher than those without bariatric surgery, although this finding did not achieve statistical significance (Table S5). There was no statistically significant association between a history of bariatric surgery and risk of graft failure. There was a tendency toward higher risk of death in those with a history of bariatric surgery compared with those without, although this finding also did not achieve statistical significance.

4 | DISCUSSION

Historically, there have been concerns about the safety of bariatric procedures within the ESKD population who may be higher-risk surgical candidates.[12,16,17] Recently, large studies have shown a higher risk of complications related to bariatric surgery in the dialysis population than in the general population, although the absolute risk of these complications was low and potentially outweighed by the substantial gains in access to kidney transplantation following bariatric surgery.[10,11,18] However, few studies have reported on the potential benefits of bariatric surgery after kidney transplantation, and the existing data on posttransplant outcomes are derived primarily from single-center experiences.[16,19–23] These data would be helpful when counseling dialysis patients regarding the risk and benefits of undergoing bariatric surgery prior to kidney transplantation. We believe our study is one of the few to examine the outcomes of individuals who received bariatric surgery prior to kidney transplantation using a national cohort of patients with ESKD. Overall, we found that bariatric surgery prior to kidney transplantation was not associated with the risk of 30-day readmissions, graft failure, or death. However, sleeve gastrectomy (vs. no bariatric surgery) prior to kidney transplantation was associated with a significantly lower risk of graft failure.

Although its use has increased gradually over the last decade, the rates of bariatric surgery among the obese dialysis population have remained low.[10] Two recent studies showed that compared with patients with normal kidney function, patients with ESKD who underwent bariatric surgery had a higher risk of medical and surgical complications and higher risk of death, but the absolute difference in the risk for these complications was small.[10,24] A prior study using USRDS data between 1991 and 2004 showed a higher risk of death in bariatric surgery patients undergoing dialysis, but this likely occurred in an era where open Roux-en-Y procedures were the most common type of bariatric procedure.[25] Our data did not show a statistically significantly higher risk of death among patients who received bariatric surgery compared to those who did not prior to transplantation. We did find a tendency toward higher odds of 30-day readmission following kidney transplantation in those with Roux-en-Y and laparoscopic banding, and the most common reason for readmissions was surgical-related complications, although this finding did not consistently achieve statistical significance. However, other studies have also shown a risk for surgical complications following bariatric surgery.[26]

Our data also suggest that overall, patients who received bariatric surgery prior to kidney transplantation have similar patient or allograft survival compared with those who did not receive bariatric surgery. Recipients of sleeve gastrectomy had lower risk of graft failure compared to those who did not undergo bariatric surgery. These results are consistent with single-center studies that have also suggested a benefit of bariatric surgery on graft function in matched studies, at least in the short term.[21,27] However, because our reference group included dialysis patients who were able to undergo kidney transplantation despite the presence of (morbid) obesity and who circumvented this barrier to kidney transplantation, the benefits of bariatric surgery may be attenuated in our study. Although the difference in BMI at transplant was only 1 kg/m^2 between those who underwent bariatric surgery versus those who did not, bariatric surgery, particularly via sleeve gastrectomy, may confer additional metabolic benefits, thus decreasing the risk of graft failure. Furthermore, we would note that the difference between those with and without bariatric surgery may not be as large as expected at the time of kidney transplant due to the requirement for certain BMI thresholds to be met in order for patients to be eligible for kidney transplantation.[28]

We also did not find a statistically significant association between history of bariatric surgery and risk for acute rejection following transplantation. Although there have been concerns about drug malabsorption,[29–31] and some case reports and small studies have suggested the presence of altered absorption and pharmacokinetics of tacrolimus following bariatric surgery[32,33] we did not see strong evidence of an increased risk for rejection after bariatric surgery in our cohort.

Several limitations should be noted. First, our study is limited to the population with Medicare fee-for-service coverage due to our reliance on claims data for ascertainment of bariatric surgery and readmissions, and our results may not be applicable to other populations such as those cared for by the Veterans Health Administration or those with

Medicare Advantage. Second, we also note that patients who were able to qualify for kidney transplant surgery without bariatric surgery may differ in other ways from those who underwent bariatric surgery, and residual confounding may be present. In particular, patients who required bariatric surgery to achieve weight loss were younger, tended to have very high BMI at dialysis initiation (mean BMI is 44 kg/m^2) and had higher prevalence of diabetes at dialysis initiation compared with those who did not require bariatric surgery. Last, we do not have long-term data on control of diabetes and hypertension or weight trajectory among transplant recipients, which are important benefits that bariatric surgery may confer but are not addressed by this study.

In conclusion, bariatric surgery in the morbidly obese dialysis population with Medicare was associated with similar re-admission rates, kidney survival, and patient survival compared to no bariatric intervention during intermediate-term follow-up. However, differences were noted across the various types of bariatric surgery. In particular, sleeve gastrectomy in dialysis patients was associated with lower risk of subsequent graft failure. Overall, our findings suggest that sleeve gastrectomy may be an under-utilized option for patients who are ineligible for kidney transplantation due to the inability to meet the body mass index criteria set by transplant centers. As advances in surgical techniques continue, greater recognition and acceptance of bariatric surgery as an option for the advanced CKD and ESKD populations by providers and patients may be associated with improved access to transplantation and graft survival. However, longer-term studies with granular data are needed to assess the safety of bariatric surgery after transplantation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in USRDS at www.usrds.org, Ref. [13].

Abbreviations:

ESKD	end-stage kidney disease
HCPCS	Healthcare Common Procedure Coding System

KDPI	Kidney Donor Profile Index
USRDS	United States Renal Data System

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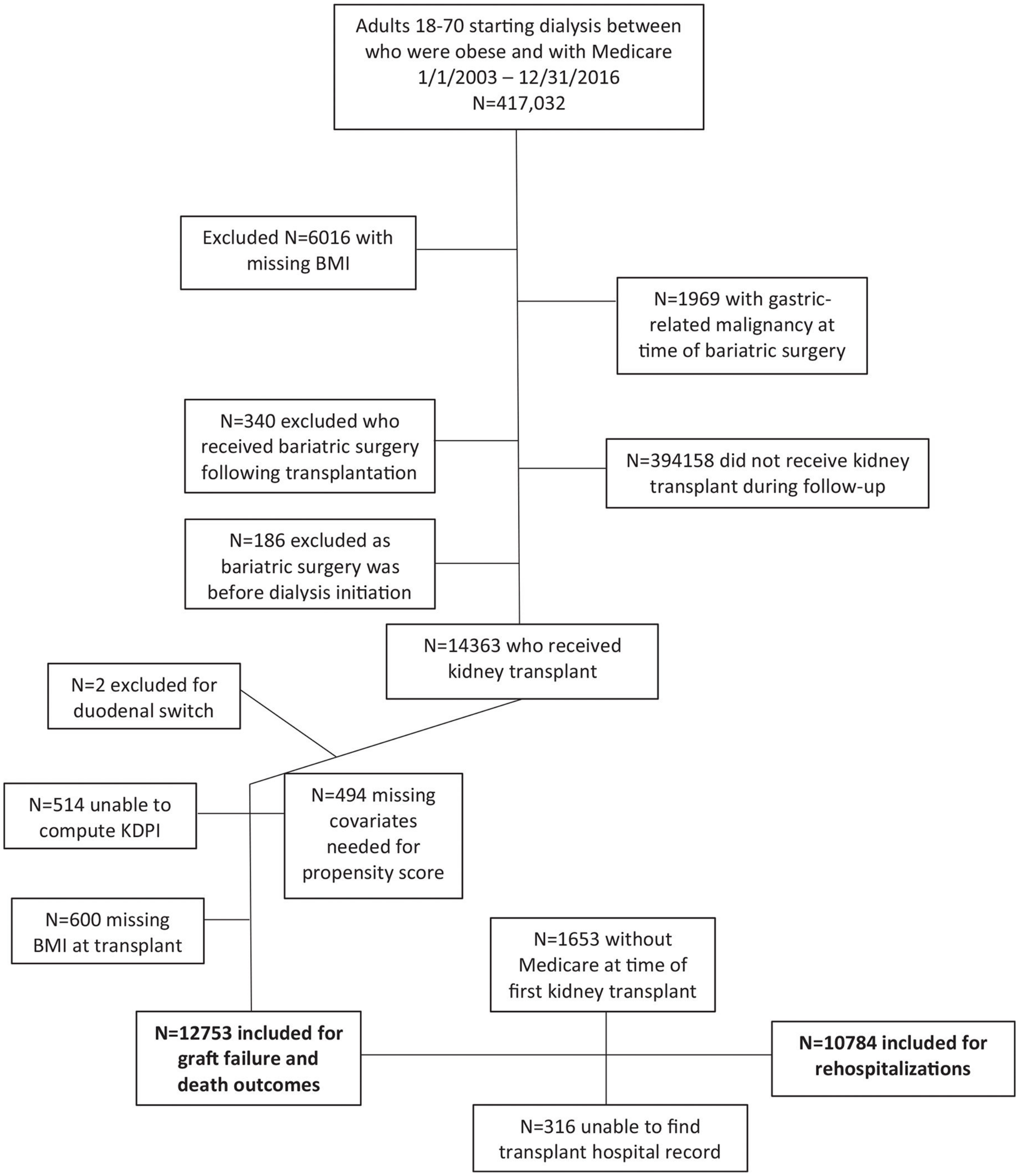

FIGURE 1.
Consort diagram

TABLE 1

Characteristics of kidney transplant recipients with Medicare included for study

Mean ± SD or % unless otherwise specified	No history of bariatric surgery *N* = 12 250	History of bariatric surgery *N* = 503	Overall *N* = 12 753
Age at cohort entry (yrs)[a]	48.9 ± 12.1	43.6 ± 10.9	48.7 ± 12.1
Age at transplant (yrs)[a]	52.2 ± 11.9	48.6 ± 10.7	52.1 ± 11.8
Women[a]	41.2	54.5	41.7
Race[a]			
NHW	45.0	41.4	44.9
NHB	39.2	42.1	39.3
Hispanic	12.7	15.7	12.8
Asian	1.8	N<11[b]	1.8
Other	1.3	N<11[b]	1.3
Region of US			
West	14.4	13.7	14.4
Midwest	25.8	22.5	25.6
South	40.9	47.3	41.2
Northeast	18.9	16.5	18.9
Hemodialysis[a]	84.7	89.9	84.9
Median neighborhood income $1000 [IQR][a]	47.5 [37.6–61.4]	46.7 [36.9–58.8]	47.5 [37.6–61.4]
Comorbid conditions at dialysis onset			
CAD	8.3	7.0	8.3
HF	14.1	13.5	14.1
Smoking Hx	3.4	3.2	3.4
Drug use	0.5	N<11[b]	0.5
PVD	4.5	4.2	4.5
Alcohol use	0.6	N<11[b]	0.6
Diabetes[a]	46.9	54.5	47.2
Stroke	3.2	N<11[b]	3.1
BMI at dialysis initiation (kg/m^2)[a]	40.1 ± 5.4	44.9 ± 6.6	40.2 ± 5.5
Organ quality			
KDPI 0 to <35%	27.3	27.0	27.2
KDPI 35% to ≤85%	44.4	49.3	44.6
KDPI >85%	7.6	5.6	7.5
Living donor	20.8	18.1	20.7
BMI at transplant (kg/m^2)	34.4 ± 4.6	33.3 ± 4.8	34.4 ± 4.6
Proportion receiving deceased donor transplant	79.2	81.9	79.3
Type of bariatric surgery (%)			
Roux-en-Y	0	38.6	1.5

Mean ± SD or % unless otherwise specified	**No history of bariatric surgery *N* = 12 250**	**History of bariatric surgery *N* = 503**	**Overall *N* = 12 753**
Sleeve	0	37.8	1.5
Band	0	23.7	0.9

Abbreviations: BMI, body mass index; CAD, coronary artery disease; HF, heart failure; IQR, interquartile range; KDPI, Kidney Donor Profile Index; NHB, non-Hispanic Black; NHW, non-Hispanic White; PVD, peripheral vascular disease.

[a] $p < .05$ comparing those with and without a history of bariatric surgery.

[b] Some exact percentages are suppressed as requested by the US Renal Data System when the *N* in each cell is low.

TABLE 2

Risk of adverse outcomes in individuals who received bariatric surgery before kidney transplantation compared to those who did not in logistic, Fine-Gray, or Cox models

Outcome	Model 1 HR or OR (95% CI)	Model 2 HR or OR (95% CI)
30-day rehospitalization (*N* = 10 784[a])	1.20 (0.97–1.47)	1.23 (1.001–1.52)
Graft failure	0.95 (0.72–1.26)	1.02 (0.77–1.35)
Death	1.09 (0.83–1.43)	1.10 (0.84–1.45)

Note:

Model 1: Adjusted for propensity score and organ quality.

Model 2: Additionally adjusted for BMI at time of transplantation.

Abbreviations: HR, hazard ratio; OR, odds ratio.

[a] *N* = 10 784 due to missing claims data (see Figure 1).

TABLE 3

Risk of adverse outcomes in individuals who received bariatric surgery before kidney transplantation compared to those who did not in logistic, Cox, or Fine-Gray models by type of bariatric surgery

Outcome	**Model 1 HR or OR (95% CI)**	**Model 2 HR or OR (95% CI)**
30-day rehospitalization (*N* = 10 784[a])		
No bariatric surgery	Reference	Reference
Roux-en-Y	1.31 (0.95–1.81)	1.40(1.01–1.93)
Sleeve gastrectomy	0.91 (0.64–1.30)	0.94 (0.66–1.33)
Laparoscopic gastric banding	1.49 (1.01–2.20)	1.47 (1.00–2.17)
Graft failure		
No bariatric surgery	Reference	Reference
Roux-en-Y	0.99 (0.67–1.47)	1.04 (0.70–1.55)
Sleeve gastrectomy	0.38 (0.16–0.93)	0.39 (0.16–0.95)
Laparoscopic gastric banding	1.32 (0.86–2.02)	1.31 (0.86–2.01)
Death		
No bariatric surgery	Reference	Reference
Roux-en-Y	1.14(0.77–1.68)	1.15 (0.78–1.71)
Sleeve gastrectomy	1.26 (0.69–2.28)	1.27 (0.70–2.30)
Laparoscopic gastric banding	0.96 (0.61–1.54)	0.96 (0.60–1.53)

Note:

Model 1: Adjusted for propensity score and organ quality.

Model 2: Additionally adjusted for BMI at time of transplantation.

Abbreviations: HR, hazard ratio; OR, odds ratio.

[a] *N* = 10 784 due to missing claims data (see Figure 1).