

ESTIMATED GLOMERULAR FILTRATION RATE INCREASES AFTER BARIATRIC SURGERY

Alex Chang, MD, MS¹, Yuan Chen², Christopher Still³, Craig Wood³, H. Les Kirchner⁴, Meredith Lewis⁴, Lawrence Appel^{2,5}, Tom Greene⁶, Holly Kramer⁷, David Carey³, Morgan Grams^{2,8}

1 Geisinger Health System, Division of Nephrology, 2 Johns Hopkins University, Welch Center for Prevention, Epidemiology and Clinical Research, 3 Geisinger Health System, Obesity Institute, 4 Geisinger Health System, Center for Health Research, 5 Johns Hopkins University, Division of General Internal Medicine, 6 University of Utah, Department of Medicine, 7 Loyola University Medical Center, Division of Nephrology, 8 Johns Hopkins University School of Medicine, Division of Nephrology

BACKGROUND

- Morbid obesity is associated with a 5-6-fold increased risk of end-stage renal disease (ESRD).¹
- Bariatric surgery results in large, sustained weight loss, lowered blood pressure and improved glycemic control.^{2,3}
- Effects of weight loss on kidney function
 - Previous studies limited by small sample size^{4,5}, short duration of follow-up and lack of comprehensive clinical data⁶

SPECIFIC AIMS

- Compare trajectories of estimated glomerular filtration rate (eGFR) in patients who underwent bariatric surgery to those of matched controls
- Compare the incidence rate of eGFR decline $\geq 30\%$ in patients who underwent bariatric surgery to that of matched controls

METHODS

- Study Population – Individuals ≥ 18 years of age who received primary care in Geisinger Health System from 1/1/04 to 12/31/13.
- Assessment of kidney function – estimated glomerular filtration rate (eGFR) based on serum creatinine (CKD-EPI formula)
 - Kidney function decline defined as eGFR decline⁷ $\geq 30\%$
- Propensity-score matching – Variables used included baseline year, follow-up time, age, gender, race, weight, BMI, eGFR, eGFR < 60 ml/min/1.73m², use of statins, angiotensin converting enzyme inhibitors (ACE), angiotensin receptor blockers (ARB), and comorbidities (ICD-9 codes for hypertension, diabetes, dyslipidemia, kidney stones, gout, heart failure, urethral disorder, myocardial infarction, acute kidney injury)
 - Matched controls identified for 1249 out of 1259 bariatric surgery patients
- Statistical Analysis
 - Mixed effect models adjusted for propensity scores and baseline eGFR with random intercepts on individuals and random slopes on time, unstructured correlation between random effects
 - Cox proportional hazards regression used to examine incidence rates of eGFR decline $\geq 30\%$ adjusted for age, race, gender, body mass index, eGFR, hypertension, diabetes, and congestive heart failure

RESULTS

- Overall, participants were well-matched (Table 1).
- Weight - Surgery group had change in weight of -38.6 kg after 1 y, then +2.3 kg/y whereas the control group experienced no change after 1 y, then -0.4 kg/y (Figure 1)
- eGFR trajectories - Surgery group experienced increases in eGFR relative to control group (Table 2, Figure 1). The effect was stronger in patients with eGFR < 90 (p value for interaction < 0.001)
- eGFR decline $\geq 30\%$ - Surgery group had lower incidence rate of eGFR decline than control group (2.3 vs. 5.2 per 100 person-years) (Table 3)

Table 1. Baseline Characteristics

	Matched Surgery Patients (n=1249)	Matched Controls (n=1249)	P value
Follow-up time (y)	3.3	2.9	0.03
Age (y)	45.0	44.9	0.04
Female (%)	81.6	83.2	0.3
Black (%)	28.5	29.7	< 0.001
Weight (kg)	129.0	127.6	0.4
SBP (mmHg)	131.8	129.8	< 0.001
DBP (mmHg)	76.4	78.2	< 0.001
eGFR (ml/min/1.73 m ²)	97.1	97.4	0.2
eGFR _{unindexed} (ml/min)	129.4	129.5	0.1
HTN, %	63.7	64.7	0.6
Diabetes, %	42.0	41.9	0.9
Taking statin, %	28.1	28.7	0.8
Taking ACE or ARB, %	27.6	27.7	1.0
Surgery Type, %			
Roux-en-Y	95.4		
Sleeve	4.6		

Results are presented as means or percentages except for follow-up time, which is presented as median

REFERENCES:

- Hsu CY, McCulloch CE, Iribarren C, Darbinian J, Go AS. Body mass index and risk for end-stage renal disease. *Ann Intern Med*. 2006 Jan 3;144(1):21-8.
- Sjostrom L, Peltonen M, Jacobson P, et al. Association of bariatric surgery with long-term remission of type 2 diabetes and with microvascular and macrovascular complications. *JAMA*. 2014;311(22):2297-2304.
- Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes - 3-year outcomes. *N Engl J Med*. 2014.
- Navaneethan SD, Yehert H. Bariatric surgery and progression of chronic kidney disease. *Surg Obes Relat Dis*. 2009;5(6):662-665.
- Chagnac A, Weinstein T, Herman M, Hirsh J, Gafter U, Ori Y. The effects of weight loss on renal function in patients with severe obesity. *J Am Soc Nephrol*. 2003;14(6):1480-1486.
- Lieske JC, Mehta RA, Milliner DS, Rule AD, Bergstralh EJ, Sarr MG. Kidney stones are common after bariatric surgery. *Kidney Int*. 2015 Apr;87(4):839-45.
- Coresh J, Turin TC, Matsushita K, et al. Decline in estimated glomerular filtration rate and subsequent risk of end-stage renal disease and mortality. *JAMA*. 2014;311(24):2518-2531.

Table 2. Modeled eGFR Trajectories Over Time

	Baseline eGFR < 90		Baseline eGFR ≥ 90	
	Control Group (N=392)	Surgery Group (N=392)	Control Group (N=857)	Surgery Group (N=857)
	Estimate (95% CI)	P value	Estimate (95% CI)	P value
Baseline eGFR (ml/min/1.73m ²)	73.96 (72.49,75.43)	< 0.001	79.07 (77.47,80.67)	< 0.001
≤ 1 year eGFR slope (ml/min/1.73m ² /y)	1.44 (-0.34,3.22)	0.112	8.72 (7.03,10.42)	< 0.001
> 1 year eGFR slope (ml/min/1.73m ² /y)	-1.78 (-2.29,-1.26)	< 0.001	-2.10 (-2.55,-1.64)	< 0.001
	Baseline eGFR ≥ 90		Baseline eGFR < 90	
	Control Group (N=857)	Surgery Group (N=857)	Control Group (N=857)	Surgery Group (N=857)
Baseline eGFR (ml/min/1.73m ²)	108.01 (107.22,108.80)	< 0.001	109.07 (108.27,109.86)	< 0.001
≤ 1 year eGFR slope (ml/min/1.73m ² /y)	-4.01 (-5.25,-2.78)	< 0.001	0.22 (-0.99,1.43)	0.725
> 1 year eGFR slope (ml/min/1.73m ² /y)	-1.27 (-1.60,-0.94)	< 0.001	-1.56 (-1.89,-1.24)	< 0.001

Figure 1. Modeled Trajectories of Weight and eGFR by Baseline eGFR

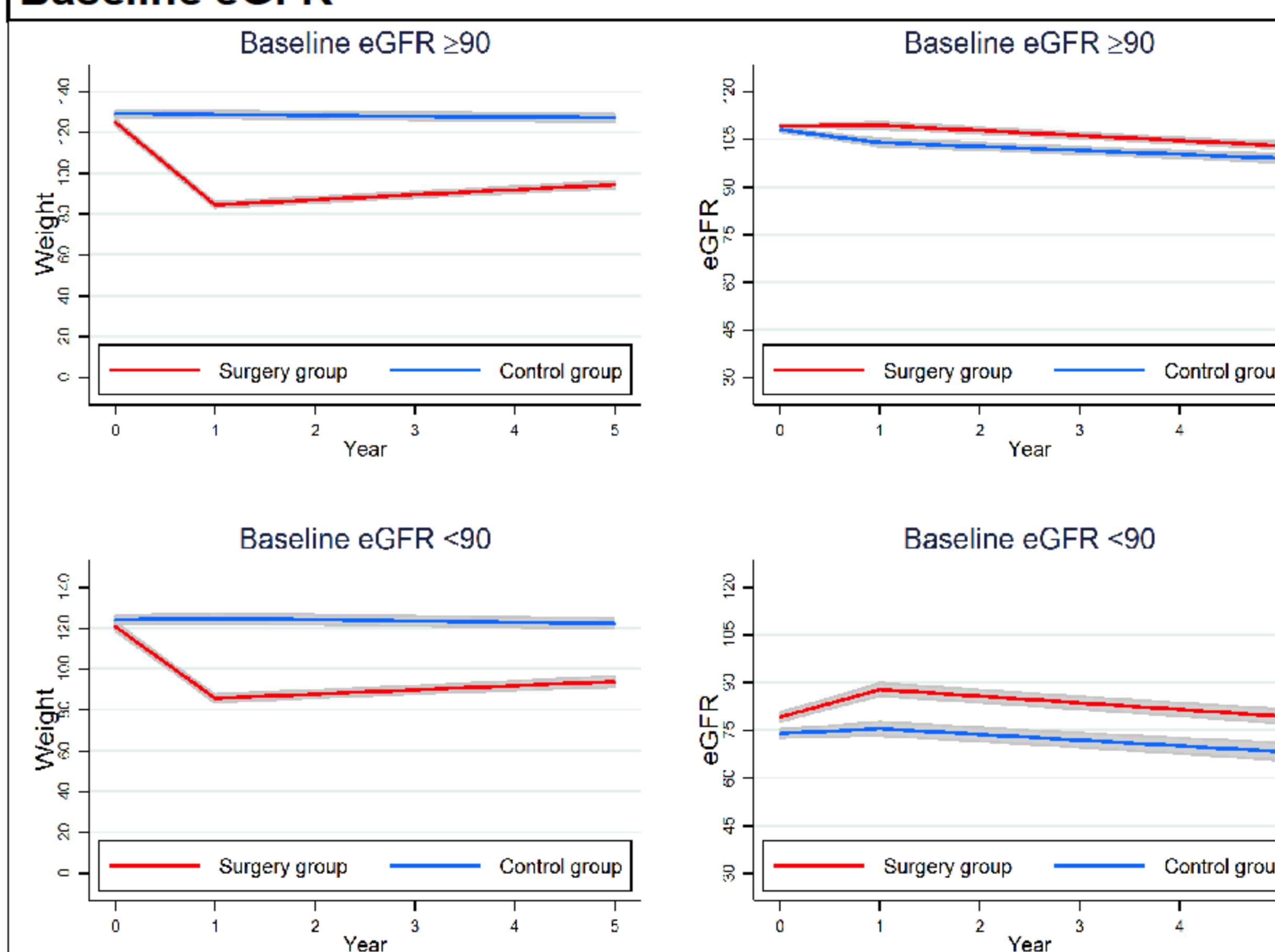


Table 3. Incidence Rates of eGFR Decline $\geq 30\%$

	Events/ N	IR (per 100 PY)	HR (95% CI)	p-value
Controls	183/995	5.23 (4.52,6.05)	1.00 (1.00-1.00)	
Surgery	93/1141	2.33 (1.90,2.86)	0.51 (0.40-0.66)	< 0.001

CONCLUSIONS

- After bariatric surgery, eGFR increases and persists up to 5 years later; this effect is stronger in patients with eGFR < 90 ml/min/1.73m²
- Bariatric surgery is associated with a 49% decreased risk of eGFR decline $\geq 30\%$
- Further research using filtration markers unaffected by body mass is needed to confirm findings

