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Effect of weight status on outcomes following endovascular abdominal aortic aneurysm repair

Analysis of NSQIP 2016-2019

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Disclosures

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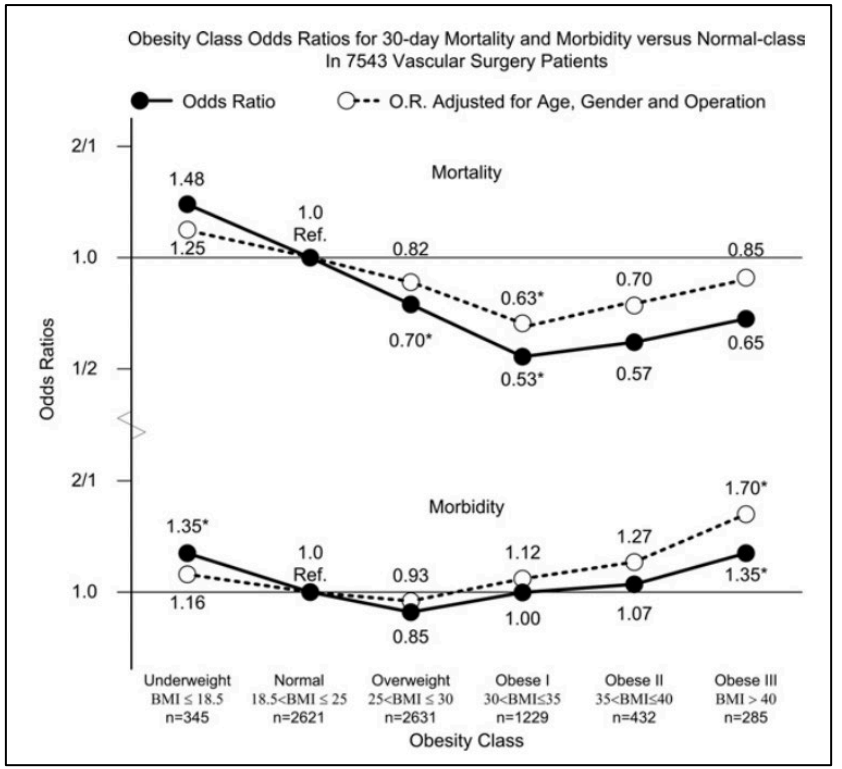
Introduction

The influence of BMI on outcomes in vascular surgery has been described as "U"- or "J"-shaped, with the worst outcomes in patients of underweight and severe obesity status.[1]

Overweight and mild obesity status has been associated with improved outcomes, termed the "obesity paradox".[1-4]

In vascular surgery patients, malnutrition is present in 24% of patients and is associated with prolonged length of stay, complications, and readmissions.[5,6]



Davenport et al. *J Vasc Surg* (2009).

Methods

How does BMI affect presentation and outcomes of EVAR?

Database: National Surgical Quality Improvement Program (NSQIP) 2016-2019

- EVAR for both ruptured and non-ruptured AAA included in initial cohort

- Patients categorized according to BMI weigh status:
  - Underweight BMI <18.5 kg/m^2
  - Normal-weight BMI 18.5-24.9 kg/m^2
  - Overweight BMI 25.0-29.9 kg/m^2
  - Obese I BMI 30.0-34.9 kg/m^2
  - Obese II BMI 35.0-39.9 kg/m^2
  - Obese III BMI >40.0 kg/m^2

Results

We identified 7,304 EVAR cases comprised of 5.0% underweight (UW), 24.3% normal-weight (NW), 37.4% overweight (OW), 21.7% Obese I, 8.1% Obese II, and 3.5% Obese III patients.

Patients with obesity significantly younger than UW, NW, and OW patients.

Lowest proportion of female patients in OW and Obese I statuses.

UW patients more often undergoing emergent or non-elective surgery.

Variable *N* (%) or median [IQR]	UW 368 (5.0)	NW 1,777 (24.3)	OW 2,731 (37.4)	Obese I 1,587 (21.7)	Obese II 588 (8.1)	Obese III 253 (3.5)	*P*
Age, years	76 [69-82]	75 [69-82]	75 [68-81]	72 [66-78]	71 [65-76]	68 [64-74]	<.001
Gender, female	112 (30.4)	458 (25.8)	456 (16.7)	266 (16.8)	125 (21.3)	71 (28.1)	<.001
Race, non-White	26 (12.0)	191 (12.5)	184 (8.0)	106 (8.0)	39 (7.8)	29 (13.6)	<.001
Ethnicity, Hispanic	4 (1.8)	30 (1.9)	58 (2.5)	23 (1.7)	11 (2.2)	2 (.9)	.501
Elective surgery	138 (37.5)	1,348 (75.9)	2,223 (81.5)	1,282 (80.8)	477 (81.1)	191 (75.5)	<.001
Emergency case	195 (53.0)	188 (10.6)	232 (8.5)	148 (9.3)	63 (10.7)	35 (13.8)	<.001

Results

Prevalence of diabetes and hypertension increased with BMI.

UW and Obese III patients had highest rates of COPD.

Preoperative hematocrit and albumin was lowest in UW patients.

Variable *N* (%) or median [IQR]	UW 368 (5.0)	NW 1,777 (24.3)	OW 2,731 (37.4)	Obese I 1,587 (21.7)	Obese II 588 (8.1)	Obese III 253 (3.5)	*P*
Dependent functional status	14 (3.9)	68 (3.8)	61 (2.2)	35 (2.2)	10 (1.7)	8 (3.2)	0.005
Current smoker	157 (42.7)	744 (41.9)	886 (32.4)	491 (30.9)	174 (29.6)	82 (32.4)	<0.001
COPD	97 (26.4)	355 (20.0)	399 (14.6)	268 (16.9)	112 (19.0)	65 (25.7)	<0.001
Congestive heart failure	12 (3.3)	3 (2.2)	50 (1.8)	27 (1.7)	7 (1.2)	17 (6.7)	<0.001
Hypertension	234 (63.6)	1,300 (73.2)	2,105 (77.1)	1,279 (80.6)	474 (80.6)	221 (87.4)	<0.001
Diabetes	39 (10.6)	171 (9.6)	383 (14.0)	324 (20.4)	140 (23.8)	72 (28.5)	<0.001
Currently on dialysis	3 (0.8)	40 (2.3)	33 (1.2)	11 (0.7)	1 (0.2)	2 (0.8)	<0.001
Bleeding disorder	50 (13.6)	220 (12.4)	333 (12.2)	205 (12.9)	62 (10.5)	34 (13.4)	0.686
Preoperative hematocrit (%)	38 [33.2-42]	39.5 [35.6-43]	41.2 [37.8-44.1]	42 [38.6-45.1]	41.9 [38.5-44.9]	41.9 [37.6-44.3]	<0.001
Preoperative albumin (g/dL)	3.6 [3.0-4.0]	3.8 [3.4-4.2]	3.9 [3.5-4.2]	4.0 [3.6-4.2]	3.9 [3.5-4.2]	3.8 [3.4-4.0]	<0.001

Results

UW patients more often presented with ruptured and symptomatic AAA.

Variable *N* (%) or median [IQR]	UW 368 (5.0)	NW 1,777 (24.3)	OW 2,731 (37.4)	Obese I 1,587 (21.7)	Obese II 588 (8.1)	Obese III 253 (3.5)	*P*
Indication							<0.001
Diameter	186 (50.8)	1,386 (78.3)	2,189 (80.5)	1,252 (79.6)	485 (83.2)	191 (75.5)	
Dissection	4 (1.1)	15 (0.8)	18 (0.7)	9 (0.6)	7 (1.2)	4 (1.6)	
Thrombosis	3 (0.8)	15 (0.8)	31 (1.1)	11 (0.7)	1 (0.2)	2 (0.8)	
Embolization	1 (0.3)	7 (0.4)	12 (0.4)	4 (0.3)	3 (0.5)	1 (0.4)	
Prior endo unsatisfactory	0 (0.0)	30 (1.7)	56 (2.1)	30 (1.9)	7 (1.2)	5 (2.0)	
Prior open unsatisfactory	0 (0.0)	5 (0.3)	8 (0.3)	6 (0.4)	0 (0.0)	0 (0.0)	
Rupture with hypotension	58 (15.8)	49 (2.8)	68 (2.5)	44 (2.8)	25 (4.3)	19 (7.5)	
Rupture without hypotension	54 (14.8)	53 (3.0)	74 (2.7)	53 (3.4)	17 (2.9)	10 (4.0)	
Non-ruptured symptomatic	51 (13.9)	150 (8.5)	180 (6.6)	100 (6.4)	25 (4.3)	13 (5.1)	
Other	9 (2.5)	59 (3.3)	83 (3.1)	64 (4.1)	13 (2.2)	8 (3.2)	

Results

Non-ruptured AAA diameter was larger in UW patients compared to all others except Obese III weight status.

Ruptured AAA diameter was only significantly different between NW and Obese II weight statuses.

Operative time was prolonged in Obese III patients.

Variable Median [IQR]	UW	NW	OW	Obese I	Obese II	Obese III	*P*
Non-ruptured AAA diameter (cm)	5.8 [5.2-7.0]	5.5 [5.1-6.2]	5.5 [5.1-6.0]	5.5 [5.0-6.0]	5.5 [5.1-6.0]	5.6 [5.15-6.1]	<.001
Ruptured AAA diameter (cm)	7.0 [6.0-9.0]	6.7 [5.3-8.0]	7.0 [5.5-8.5]	7.5 [6.0-9.0]	7.8 [6.6-9.7]	7.9 [6.0-9.2]	0.022
Operative time (min)	113 [79-156]	114 [82-166]	108 [81-152]	112 [83-159]	118 [86-163]	129 [97-173]	<0.001

Results

Overall 30-day mortality was higher for UW compared to all other patients.

For non-ruptured AAA, 30-day mortality was significantly lower for OW and Obese I compared to NW patients.

Variable *N* (%) or median [IQR]	UW	NW	OW	Obese I	Obese II	Obese III	*P*
Mortality, 30 days, overall	50 (13.6)	62 (3.5)	49 (1.8)	30 (1.9)	9 (1.5)	11 (4.3)	<0.001
Mortality, 30 days, non-ruptured AAA	9 (3.7)	36 (2.2)	23 (0.9)	12 (0.8)	5 (0.9)	3 (1.3)	<.001
Mortality, 30 days, ruptured AAA	41 (33.6)	26 (23.9)	26 (16.8)	18 (17.8)	4 (9.3)	8 (28.6)	0.003

Length of stay was highest for UW patients and lowest for OW and Obese I patients.

Variable *N* (%) or median [IQR]	UW 368 (5.0)	NW 1,777 (24.3)	OW 2,731 (37.4)	Obese I 1,587 (21.7)	Obese II 588 (8.1)	Obese III 253 (3.5)	*P*
Readmission, 30 days	35 (9.5)	156 (8.8)	187 (6.8)	110 (6.9)	43 (7.3)	22 (8.7)	0.103
Unplanned reoperation, 30 days	36 (9.8)	106 (6.0)	112 (4.1)	77 (4.9)	27 (4.6)	13 (5.1)	<0.001
Total length of stay, days	3 [1-6]	2 [1-4]	1 [1-3]	1 [1-3]	1 [1-3]	2 [1-4]	<0.001

Results

Thirty-day morbidity was significantly worse for UW patients.

Infectious complications (pneumonia, SSI) were more common in Obese III patients.

Variable *N* (%) or median [IQR]	UW 368 (5.0)	NW 1,777 (24.3)	OW 2,731 (37.4)	Obese I 1,587 (21.7)	Obese II 588 (8.1)	Obese III 253 (3.5)	*P*
Superficial surgical site infection	2 (0.5)	8 (0.5)	23 (0.8)	8 (0.5)	6 (1.0)	7 (2.8)	0.002
Pneumonia	14 (3.8)	26 (1.5)	39 (1.4)	27 (1.7)	6 (1.0)	10 (4.0)	0.001
Unplanned intubation	19 (5.2)	30 (1.7)	36 (1.3)	22 (1.4)	8 (1.4)	6 (2.4)	<0.001
Pulmonary embolism	3 (0.8)	2 (0.1)	4 (0.1)	3 (0.2)	4 (0.7)	1 (0.4)	0.025
Acute renal failure	12 (3.3)	20 (1.1)	30 (1.1)	18 (1.1)	8 (1.4)	6 (2.4)	0.010
Urinary tract infection	8 (2.2)	21 (1.2)	32 (1.2)	16 (1.0)	4 (0.7)	6 (2.4)	0.169
CVA/stroke	6 (1.6)	4 (0.2)	10 (0.4)	5 (0.3)	3 (0.5)	2 (0.8)	<0.001
Cardiac arrest requiring CPR	20 (5.4)	26 (1.5)	22 (0.8)	19 (1.2)	4 (0.7)	5 (2.0)	<0.001
Myocardial infarction	18 (4.9)	39 (2.2)	41 (1.5)	20 (1.3)	1 (1.7)	3 (1.2)	<0.001
Bleeding requiring transfusion	101 (27.4)	241 (13.6)	247 (9.0)	132 (8.3)	56 (9.5)	34 (13.4)	<0.001
DVT requiring therapy	3 (0.8)	3 (0.2)	8 90.3)	3 (0.2)	4 (0.7)	0 (0.0)	0.114
Sepsis	5 (1.4)	9 (0.5)	12 (0.4)	9 (0.6)	1 (0.2)	0 (0.0)	0.132

Results

Multivariate analysis was performed to account for effect of preoperative demographics (sex, race) and comorbidities (smoking, COPD, hypertension, CHF, diabetes, dialysis, >10% body weight loss, bleeding disorder, dependent functional status), presence of ruptured AAA or dissection, urgency of intervention, and operative time.

Variable	aOR	95% CI	*P*
Age, for every decade increase	1.340	1.085-1.655	.007
Weight status (reference normal-weight)			
Underweight	1.529	.867-2.696	.143
Overweight	.472	.303-.737	.001
Obese I	.464	.272-.791	.005
Obese II	.303	.123-.748	.010
Obese III	.887	.386-2.039	.778
CHF	2.624	1.208-5.701	.015
Currently on dialysis	3.619	1.487-8.807	.005
Bleeding disorder	1.52	1.018-2.270	.041
Ruptured AAA	9.273	5.132-16.755	<.001
Emergency case	2.581	1.428-4.664	.002
Operative time, for every 30-minute increase	1.168	1.118-1.221	<.001

Summary of Findings

In this retrospective study of NSQIP 2012-2019 including 7,304 EVAR cases:

1. UW patients more often presented with ruptured AAA and as a result, suffered significantly worse mortality and morbidity than all other weight statuses.

2. After accounting for aneurysm rupture and baseline comorbidities, underweight status was no longer predictive of 30-day mortality.

3. Obese III status was associated with increased wound and respiratory complications but not short-term mortality.

4. Patients with OW or Obese I and II statuses had significantly lower adjusted 30-day mortality compared to NW patients.

Conclusion

Underweight patients account for only 5% of EVAR cases but 24% of mortalities.

Presence of ruptured AAA, emergency surgery, advanced age, and higher proportion of female patients largely accounts for disparate outcomes in underweight patients.

This signals an opportunity for earlier diagnosis, optimization, and treatment of AAA in this population.

Severe obesity is associated with wound and respiratory complications.

Overweight and mild-to-moderate obesity is associated with improved short-term outcomes after EVAR, adding evidence to the concept of an obesity paradox in aortic vascular surgery.

Limitations:
- Retrospective design
- Outcomes limited to 30 days and do not capture long-term effects of obesity

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