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# Patient characteristics and outcomes among bariatric surgery patients with high narcotic overdose scores

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## Abstract

**Background** Obesity-related chronic pain can increase the risk of narcotic abuse in bariatric surgery patients. However, assessment of overdose risk has not been evaluated to date.

**Methods** A NARxCHECK® overdose score (“Narx score”) was obtained preoperatively on all patients undergoing bariatric surgery ( $n = 306$ ) between 2018 and 2020 at a single-center academic bariatric surgery program. The 3-digit score ranges from 000 to 999 and is based on patient risk factors found within the Prescription Drug Monitoring Program. A Narx score  $\geq 200$  indicates tenfold increased risk of narcotic overdose. Patient characteristics, comorbidities, and emergency room (ER) visits were compared between patients in the upper ( $\geq 200$ ) and lower (000) terciles of Narx scores. Morphine milligram equivalent (MME) prescribed at discharge and refills was also evaluated.

**Results** Patients in the upper tercile represented 32% ( $n = 99$ ) of the study population, and compared to the lower tercile ( $n = 101$ , 33%), were more likely to have depression (63.6% vs 38.6%,  $p = 0.0004$ ), anxiety (47.5% vs 30.7%,  $p = 0.0150$ ), and bipolar disorder (6.1% vs 0.0%,  $p = 0.0120$ ). Median MME prescribed at discharge was the same between both groups (75); however, high-risk patients were more likely to be prescribed more than 10 tablets of a secondary opioid (83.3% vs 0.0%,  $p = 0.0111$ ), which was prescribed by another provider in 67% of cases. ER visits among patients who did not have a complication or require a readmission was also higher among high-risk patients (7.8% vs 0.0%,  $p = 0.0043$ ). There were no deaths or incidents of mental health-related ER visits in either group.

**Conclusion** Patients with a Narx score  $\geq 200$  were more likely to have mental health disorders and have potentially avoidable ER visits in the setting of standardized opioid prescribing practices. Narx scores can help reduce ER visits by identifying at-risk patients who may benefit from additional clinic or telehealth follow-up.

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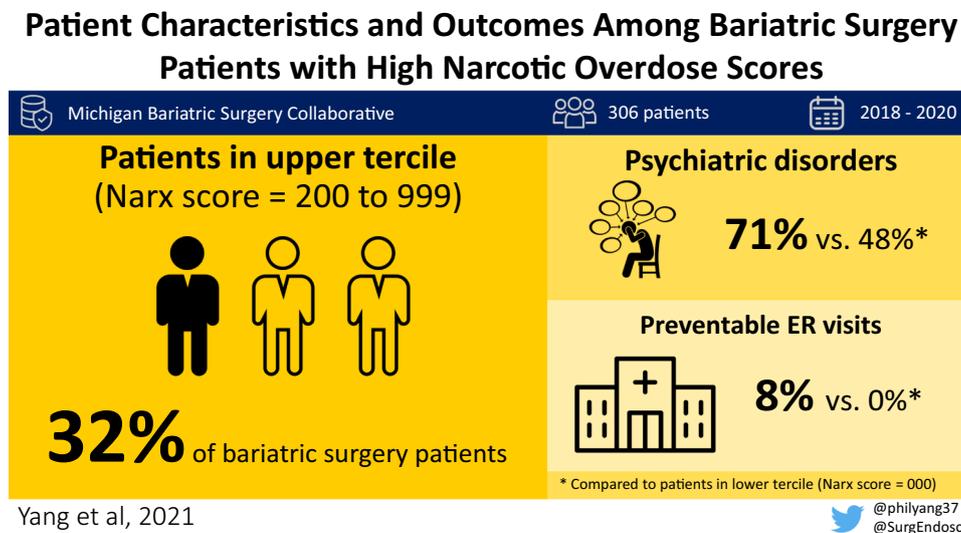
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## Graphical abstract



**Keywords** Bariatric surgery · Opioids · Narcotics · Overdose · ER visits

Obesity is associated with increased risk of prescription opioid use as a result of weight-related chronic pain conditions [1, 2]. In fact, a Body Mass Index (BMI) of 40–49.9 kg/m<sup>2</sup> is associated with 158% increased odds of incident long-term prescription opioid use, with joint pain, back pain, injury, and muscle and nerve pain among the most common reasons for opioid use [3]. In addition, the incidence of new persistent opioid use is as high as 6.3% among patients undergoing primary bariatric surgery [4]. Although bariatric surgery is the most effective and durable treatment for obesity, candidates may be at higher risk for opioid misuse postoperatively, especially in the setting of chronic prior use. To date, there are no data on the overdose risk among patients undergoing bariatric surgery.

An objective measure to predict unintentional overdose from narcotics has been developed using data from the Prescription Drug Monitoring Program (PDMP), which generates three-digit NARxCHECK® scores ranging from 000 to 999 for Narcotics, Sedatives, Stimulants, and Overdose. An overdose score (“Narx score”) of 000 indicates no prior narcotic, sedative, or stimulant prescriptions, while a Narx score of 200 increases the odds ratio of unintentional overdose death by 10 [5]. The Michigan Automated Prescription System (MAPS) is the state’s PDMP that provides prescribers and dispensers with real-time prescription data and analytics of controlled substances and schedule 2–5 drugs that have been dispensed, and the report provides the Narx score, which is also used to guide when naloxone should be prescribed [6]. The MAPS report must be reviewed by providers before prescribing any opioids [7].

In this context, we hypothesized that patients with higher Narx scores will have higher rates of postoperative ER visits and narcotic refills. As such, we utilized a statewide bariatric-specific clinical registry to identify patients undergoing bariatric surgery at a single-center academic institution. We evaluated the relationship between preoperative Narx scores and patient characteristics, opioid prescribing patterns, and postoperative emergency room (ER) visits among patients with high and low scores.

## Materials and methods

### Study design

This study was designed to characterize the distribution of Narx scores among patients undergoing bariatric surgery and compare prescribing practices and ER visits between patients with high and low scores. A Narx score was obtained during the preoperative assessment on all patients undergoing bariatric surgery ( $n = 306$ ) between 2018 and 2020 at a single-center academic bariatric surgery program. Patient characteristics, comorbidities, length of stay, morphine milligram equivalent (MME) prescribed at discharge, and number of refills and ER visits within 30 days of surgery were obtained using data from the Michigan Bariatric Surgery Collaborative (MBSC), a statewide bariatric-specific clinical data registry used for clinical quality improvement [8]. Patients were stratified into terciles according to their

Narx score: lower tercile = 000, middle tercile = 001 to 199, and upper tercile = 200 to 999.

The primary outcome variable was number of refills within 30 days of surgery. Secondary outcome measures included both ER visits and preventable ER visits within 30 days of surgery, MME prescribed at discharge, and length of stay. Preventable ER visits were defined as ER visits among patients who did not have a complication or require readmission.

## Data collected

NARxCHECK® analyzes data from PDMPs using a patented algorithm to generate a 3-digit Narx score [5]. The Narx score is a weighted combination of many variables: drug equivalents, number of providers, potentiating drugs, number of pharmacies, and number of overlapping prescription days. In any given population, Narx scores are distributed such that about 75% of scores are below 200, about 5% are above 500, and about 1% of scores are above 650. Additionally, the number of active prescriptions that a patient will have, assuming medications are taken as directed, is represented by the last digit of the Narx score. Under state law, Narx scores must be reviewed by providers before prescribing any opioids.

Our standard pain management protocol was for 10 pills of 5 mg oxycodone, unless there was an intolerance or allergy. Additional practices to help prevent overprescribing opioids and decrease the rate of new persistent use included eliminating patient controlled analgesia, administering transversus abdominis plane blocks in the OR, using IV acetaminophen for gastric bypass and IV ketorolac for sleeve gastrectomy patients, and providing abdominal binders and hot and ice packs for multimodal pain therapy.

Patient characteristics collected include age, preoperative BMI, sex, race, education, marital status, employment, disability, and insurance type. Patient comorbidities included diabetes, hypertension, hyperlipidemia, sleep apnea, mobility disorder, psychologic disorder, depression, anxiety, bipolar disorder, and eating disorder. All patients underwent either laparoscopic gastric bypass or laparoscopic sleeve gastrectomy.

## Statistical analysis

Patients were divided into three tercile groups based on their overall Narx scores with patients with scores of 000 as the lower tercile, scores from 1 to 199 as the middle tercile, and scores 200 to 999 as the upper tercile.

Comparisons of baseline patient characteristics were performed between the upper and lower terciles using independent samples *t* tests for continuous variables

and  $\chi^2$  tests for categorical characteristics. In order to compare baseline Narx scores, we used non-parametric Mann–Whitney *U* tests to compare medians between the upper and lower terciles.

Risk and reliability-adjusted comparisons of 30-day prescribing patterns and complication rates were compared between the upper and lower terciles using multivariate logistic regression for categorical outcomes and multivariate linear regression for continuous outcomes.

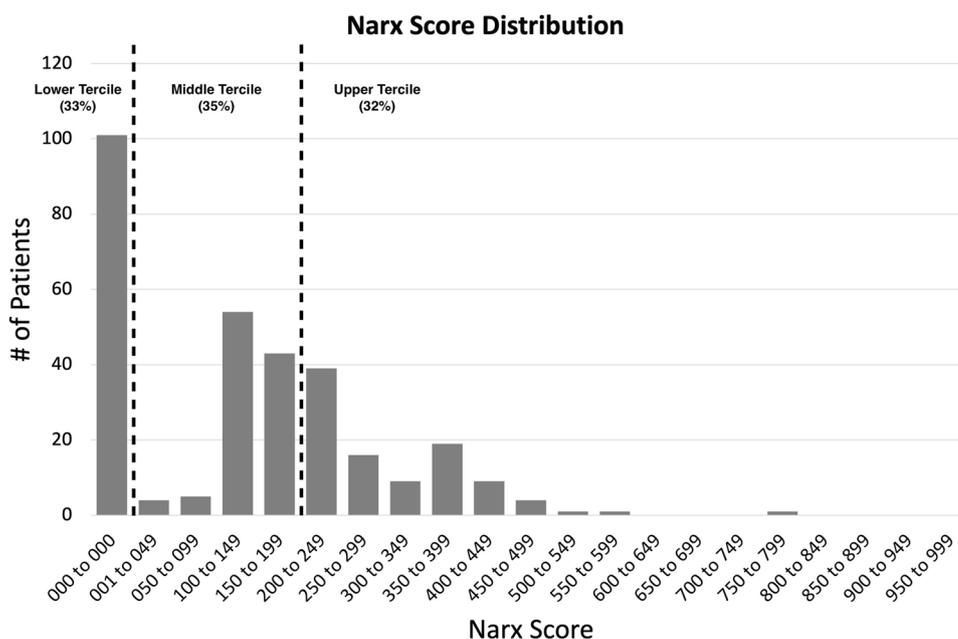
## Results

A total of 306 patients were included in the study. Overall mean age was 45.1 years, 20.9% were male, 78.0% were White, and the mean preoperative BMI was 48.0 kg/m<sup>2</sup>. Figure 1 shows the distribution of Narx scores in this study cohort. For the entire cohort, the preoperative median Narx score was 120. Patients in the upper tercile had a baseline median Narx score of 280 and patients in the middle tercile had a median Narx score of 120.

Table 1 compares patient characteristics, preoperative comorbid conditions, and procedure type between the upper and lower terciles. Patients had similar age (46.3 vs. 43.9 years,  $p = 0.1117$ ) and preoperative BMI (48.3 vs. 47.7 kg/m<sup>2</sup>,  $p = 0.5771$ ). Proportions of patients with diabetes, hypertension, sleep apnea, and mobility disorder were also similar between the upper and lower terciles. When compared to patients in the lowest tercile, patients in the upper tercile were more likely to have psychiatric disorders (70.7% vs. 47.5%,  $p = 0.0009$ ), specifically, depression (63.6% vs 38.6%,  $p = 0.0004$ ), anxiety (47.5% vs. 30.7%,  $p = 0.0150$ ), and bipolar disorder (6.1% vs. 0.0%,  $p = 0.0120$ ). Similar proportions of patients in the upper and lower terciles underwent gastric bypass and sleeve gastrectomy.

Table 2 shows that the median MME prescribed at discharge was the same between patients in the upper and lower terciles (75 MME). However, patients in the upper tercile were more likely to be prescribed more than 10 tablets of a secondary opioid (83.3% vs. 0.0%,  $p = 0.0111$ ) after hospital discharge. In addition, in 67% of the cases, the secondary opioid prescription was prescribed by a provider who was not with the bariatric surgery program. ER visits among patients who did not have a complication or require a readmission were also higher among patients in the upper tercile (7.8% vs. 0.0%,  $p = 0.0043$ ). Of these preventable ER visits, all patients presented with symptoms (i.e., postoperative pain or nausea) without any additional diagnoses. There were no reported deaths, overdoses, or incidences of mental health-related visits to the ER in either group.

**Fig. 1** Distribution of Narx scores for patients undergoing bariatric surgery between 2018 and 2020 at a single-center academic center



## Discussion

This is the first study to report Narx scores among patients undergoing bariatric surgery, thus shedding new light on the burden of obesity-related pain as well as postoperative opioid prescribing practices at a single-center academic institution. We found that patients in the upper tercile for Narx score (32% of patients) had a score of 200 or greater, indicating a tenfold increased risk of unintentional overdose death as compared to opioid-naïve patients [5]. Patients in the upper tercile for Narx score were also more likely to have depression, anxiety, bipolar disorder, and preventable ER visits when compared to patients in the bottom tercile. Although there was no difference in MME prescribed at discharge among the groups, we found that patients with the highest Narx scores were more likely to be prescribed more opioids after their hospital discharge and that refills were more likely prescribed by another provider. Our study demonstrates that obtaining Narx scores preoperatively may help tailor opioid prescribing practices and also identify at-risk patients who may benefit from additional strategies to further decrease opioid use and preventable ER visits.

These results are consistent with the literature suggesting that obesity is associated with prescription opioid use due to weight-related chronic pain conditions, particularly joint pain, back pain, injury, and muscle and nerve pain [1–3]. Our findings contribute to the literature by investigating the association of preoperative Narx scores with characteristics, complications, and outcomes of patients undergoing bariatric surgery. Narx scores have been evaluated among patients undergoing elective spine surgery, and no association was found between Narx scores and rates of adverse

events, readmission, reoperation, or mortality [9]. In patients undergoing primary total hip, higher Narx scores were associated with higher odds of 90-day all-cause readmission, procedure-related admission, longer length of stay, and non-home discharge [10]. In bariatric surgery, studies have examined the effects of opioid use on patient outcomes. Shockcor et al. showed similar weight loss, 30-day readmission, reoperation, venothrombotic event rate, bleeding rate, and infection rate between chronic prescription opioid users and opioid-naïve controls [11]. Raebel et al. demonstrated that 8% of patients in their study population were chronic opioid users, with 77% of these patients continuing opioid use one year after surgery. Furthermore, they showed that MMEs for these patients increased postoperatively, but no change in MME was found in the subgroup of patients with depression or chronic pain [12]. These studies in bariatric surgery provide insight into the impact of preoperative opioid use on patient outcomes but only divides patients into binary categories (i.e., chronic vs. not chronic opioid users) rather than further stratifying opioid users based on an objective risk score.

In our study of bariatric surgery patients, only 67.7% of patients had a Narx score less than 200, which is approximately 7% lower than the expected proportion of patients in this range of Narx scores. According to the NARxCHECK@ algorithm, in any given population, the distribution of scores are such that about 75% of scores are less than 200, about 5% are above 500, and only 1% are above 650 [5]. In two studies, 74.9% of patients undergoing primary total hip arthroplasty and approximately 75% of patients undergoing elective spine surgery had a Narx score below 200 [9, 10]. The smaller proportion of bariatric surgery patients with a

**Table 1** Comparison of demographics, comorbidities, and procedure type between upper and lower terciles according to Narx score

% or mean (range)	Overall	Lower tercile (Narx score 000 to 000)	Middle tercile (Narx score 001 to 199)	Upper tercile (Narx score 200 to 999)	<i>p</i> -value
<i>n</i>	306	101 (33%)	106 (35%)	99 (32%)	
NARxCHECK® (Median)					
Narcotics	40.0	0.0	40.0	120.0	< 0.0001
Stimulants	0.0	0.0	0.0	0.0	0.1271
Sedatives	25.0	0.0	30.0	80.0	< 0.0001
Overdose (“Narx score”)	120.0	0.0	120.0	280.0	< 0.0001
Demographics					
Age	45.1 (21.8–75.3)	43.9 (21.8–70.3)	45.2 (22.9–75.3)	46.3 (24.8–72.0)	0.1117
Preoperative BMI	48.0 (35.5–72.5)	47.7 (35.7–69.2)	48.0 (35.5–68.6)	48.3 (36.0–72.5)	0.5771
% Male	20.9	27.7	19.8	15.2	0.0305
White	78.0	70.7	80.5	83.1	0.0647
Non-white	22.0	29.3	19.5	16.9	0.0647
College	90.8	95.2	92.3	84.4	0.0233
Married/Sig other	57.8	65.1	54.6	53.3	0.1285
Employed	73.6	75.9	81.0	63.6	0.0907
Disabled	9.6	6.0	8.9	14.3	0.0818
Private insurance	89.2	93.1	91.5	82.8	0.0259
Medicare	8.8	5.9	6.6	14.1	0.0533
Medicaid	1.6	1.0	0.9	3.0	0.3028
Comorbidity					
Diabetes	36.0	38.6	33.0	36.4	0.7424
NIDDM	67.3	69.2	62.9	69.4	0.9840
IDDM	32.7	30.8	37.1	30.6	0.9840
Hypertension	47.1	41.6	46.2	53.5	0.0906
Hyperlipidemia	39.5	30.7	41.5	46.5	0.0219
Sleep apnea	69.3	69.3	71.7	66.7	0.6890
Mobility disorder	4.9	3.0	5.7	6.1	0.2919
Psychiatric disorder	63.7	47.5	72.6	70.7	0.0009
Depression	54.3	38.6	60.4	63.6	0.0004
Anxiety	43.5	30.7	51.9	47.5	0.0150
Bipolar disorder	2.6	0.0	1.9	6.1	0.0120
Eating disorder	2.3	0.0	5.7	1.0	0.3113
Procedure type					
Gastric bypass	8.8	10.9	9.4	6.1	0.2207
Sleeve gastrectomy	91.2	89.1	90.6	93.9	0.2207

*NIDDM* non-insulin-dependent diabetes mellitus, *IDDM* insulin-dependent diabetes mellitus

*p*-value displayed is for Mann–Whitney–signed rank test due to non-normally distributed data

low Narx score is further evidence that obesity is associated with elevated odds of prescription opioid use, likely due to weight-related chronic pain conditions [1, 2].

Overall, only 3.9% of patients in this study required a secondary opioid prescription, and this proportion was not significantly different between patients in the upper and lower terciles (6.2% vs. 3.0%,  $p = 0.2844$ ). This finding suggests that for most patients, current opioid prescriptions at discharge are sufficient to achieve adequate pain control after surgery. Friedman et al. reported that as recently as

late 2017, opioid prescriptions were still variable and excessive for most patients undergoing bariatric surgery ( $n = 53$  for sleeve gastrectomy,  $n = 50$  for gastric bypass,  $n = 12$  for laparoscopic adjustable gastric banding) [13]. Furthermore, Ehlers et al. showed that in their study population of 33 patients undergoing bariatric surgery, 73% had leftover narcotics, only 36% thought they had been prescribed “too much” pain medication, and 53% kept leftover opioids rather than disposing of them [14]. Similarly, in a national survey among the US adults with recent opioid medication use,

**Table 2** Comparison of opioid prescribing practices and 30-day risk-adjusted outcomes between upper and lower terciles according to Narx score

% or mean (range)	Overall	Lower tercile (Narx score 000 to 000)	Middle tercile (Narx score 001 to 199)	Upper tercile (Narx score 200 to 999)	<i>p</i> -value
<i>n</i>	306	101	106	99	
Opioid prescribing practices					
% Prescribed with an opioid at discharge	87.3	85.2	89.6	86.9	0.7259
By surgeon	99.6	98.8	100.0	100.0	0.3159
Other provider	0.4	1.2	0.0	0.0	
Median total MME prescribed at discharge	75 (0–1500)	75 (0–225)	75 (0–562.5)	75 (0–1500)	0.5715
% secondary opioid prescribed	3.9	3.0	2.9	6.2	0.2844
By surgeon	58.3	100.0	66.7	33.3	0.1667
Other provider	41.7	0.0	33.3	66.7	
Secondary opioid quantity					
< 10	33.3	100.0	33.3	0.0	0.0111
10	8.3	0.0	0.0	16.7	
> 10	58.3	0.0	66.7	83.3	
30-day risk-adjusted outcomes					
Any complications	9.3	8.1	7.7	13.2	0.3547
Extended length of stay	1.8	1.4	1.4	2.8	0.4898
Readmissions	3.4	4.2	2.9	3.0	0.8578
ER visits	10.1	7.1	10.3	13.3	0.4917
ER visits (without readmission or complications)	5.2	0.0	8.5	7.8	0.0043

*NIDDM* non-insulin-dependent diabetes mellitus, *IDDM* insulin-dependent diabetes mellitus

*p*-value displayed is for Mann–Whitney–signed rank test due to non-normally distributed data

Kennedy-Hendricks et al. reported that 61.3% of respondents reported keeping leftover opioid medications for future use [15]. Any excess opioid medication that is not properly disposed of still carries a risk for overdose in the patient and in others, as 20.7% of patients reported ever having shared opioid medications with another person [15]. Although Narx scores were predictive of secondary prescriptions from another provider and preventable ER visits, it remains to be seen if the score can be used for patient-specific prescribing practices to further reduce opioid use and excessive opioid prescriptions among patients undergoing bariatric surgery.

It is important to note that our bariatric surgery program was actively engaged in a statewide initiative to decrease opioid prescribing during the study period, which likely explains why we found no differences in MME prescribed at discharge among the groups. The University of Michigan does this through the Michigan Opioid Prescribing Engagement Network (M-OPEN) and is the coordinating center and participant of the Finding Useful Techniques to Upgrade Recovery Enhancement (FUTURE) initiative through the MBSC, which includes using multimodal pain therapy to reduce opioid use. After this study was conducted, our bariatric surgery program further reduced the standard prescription of opioids to 8 pills of 5 mg oxycodone for patients with preoperative Narx scores of 000 to 100, especially since

12.7% of all patients in this study did not require an opioid prescription at discharge. The MBSC is now actively engaged in studies that evaluate opioid-free bariatric surgery.

Overall, 10.1% of patients presented to the ER within 30 days of surgery. Even though there was no statistically significant difference in rates of ER visits between patients in the upper and lower terciles, patients in the upper tercile had higher rates of preventable ER visits (i.e., ER visits that were not due to a complication and did not require readmission) as compared to the lower tercile. Khouri et al. found anxiolytic prescription at discharge (odds ratio 5.4 [95% confidence interval 1.6–18.6]) to be an independent risk factor associated with preventable ED visits [16]. In this context, the higher prevalence of psychiatric disorders in patients in the upper tercile may be a contributing factor for the increased rates of preventable ER visits in this group. Furthermore, opioids are known to exacerbate nausea, vomiting, and constipation after surgery [17]. The larger amounts of secondary opioid prescriptions in patients in the upper terciles may also contribute to ER visits for medication side effects that were not severe enough to require readmission.

We believe that Narx scores can help providers identify at-risk patients who may benefit from more rigorous pre-surgical counseling as well as additional clinic or telehealth follow-up after surgery. For these patients, studies suggest

that the best outcomes can be achieved by giving patients realistic expectations of the anticipated postoperative pain and managing these expectations via patient education and specifically written instructions before the surgery [18]. Our typical follow-up after bariatric surgery is at 2 weeks, 2 months, 6 months, and then annually thereafter. For at-risk patients, additional in-person clinic visits or telehealth appointments within the first month after surgery may help address unanticipated patient concerns, minimize secondary opioid prescriptions written by providers not part of the bariatric surgery program, and decrease rates of preventable ER visits.

## Limitations

This study has several limitations. First, this study only includes patients undergoing bariatric surgery at a single-center academic bariatric surgery program between 2018 and 2020, which may limit generalizability. Calculating a Narx score was not a part of the electronic medical record functionality until 2018, so data prior to this date could not be captured. Nevertheless, we did have 100% data capture rate on all patients, which included follow-up at 30 days. Second, Narx scores were not blinded from providers during the study period. Blinding was not possible as it is state law for prescribers to review all patients' Narx scores before prescribing narcotics, so we are unable to determine whether knowledge of higher or lower Narx scores had any impact on decision-making for treatment of pain. Third, we evaluated opioid prescriptions and additional need through refills as a proxy for narcotic use, which may result in inaccuracies. Specifically, patients could have had illicit opioid use, thereby underestimating the actual amount of opioid use after surgery or alternatively, patients may not have filled their prescription and not used any opioids at all. Finally, it should be noted that data obtained for this study occurred during a period when standardized prescribing practices were in effect in order to reduce opioid use. These practices explain why the median MME prescribed at discharge for all group were similar and also why 12.7% of patients did not require a prescription for opioids at discharge, even among patients in the upper tercile of Narx scores.

## Conclusion

Bariatric surgery patients with a Narx score of 200 or more were more likely to have mental health disorders and were also more likely to have preventable ER visits than opioid-naïve patients. Narx scores can help providers identify at-risk patients who may benefit from additional preoperative counseling and additional follow-up to reduce unnecessary

ER visits or overprescribing of opioids after bariatric surgery.

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## Declarations

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