Characteristics of patients undergoing bariatric surgery in an underserved minority population - Does OSA affect postoperative weight loss?

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Article

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Abstract
Obese patients are at increased risk of Obstructive Sleep Apnea (OSA). Bariatric surgery is an important therapeutic measure in obese patients for management of weight and management of comorbidities. There is a scarcity of data on OSA, in inner city Hispanic and Black patients who undergo bariatric surgery. Differences between patients with and without OSA have not been assessed in this population. The study aims to answer these questions.

Introduction
In a study of the National Health and Nutrition Examination Survey (NHANES) database, Ogden et al, showed that over the last two decades, the prevalence of obesity has increased among men and women in the U.S. The study also showed that there was a greater increase in obesity in Mexican American men that non-Hispanic White men [1]. Obesity remains the strongest risk factor for development of Obstructive Sleep Apnea and both diseases increase cardiovascular risk [2]. Bariatric surgery is now recognized as an important option for permanent and sustainable weight loss [3].

There is scarcity of data available on Hispanic patients undergoing bariatric surgery. Zhao et al, in their meta-analysis, found a total of 52 studies on the topic of post-operative weight loss comparing at least two races. Out of these 52 studies, only 20 studies included Hispanic patients. Some of these studies have less than 10% Hispanic representation, going as low as 4.7%. In addition, many studies have less than a year of follow up [4].

To address this data vacuum, the following study was undertaken. In New York City, the Burrough with the highest prevalence of obesity is the Bronx (30.5%) [5]. The Burrough with the highest number of Hispanic and Black people is also the Bronx. As a result, the hospital where the study was conducted has a large pool of inner-city patients Hispanic or Black patients. This allowed analysis of outcomes and characteristics in this underserved and understudied population.

Objectives:
The study aimed at finding out the various characteristics of patients qualifying for bariatric surgery, including, anthropometric measures and lab tests. It also aimed to find out if there existed any significant difference between bariatric candidates with OSA and without OSA based on these findings. Finally, the study aimed to analyze the post operative outcome of the bariatric surgery in these patients at 6 months and 1 year, with regards to weight loss.

Methods
Data collection
This was a single center, multi-surgeon study, retrospective study. The study protocol was approved by the Institutional Review Board (IRB 04132305). All research was conducted in accordance with guidelines set forth by the Belmont Report and the Common Rule (the federal policy for the protection of human subjects). No identifiable information of the study population has been provided in the manuscript. No intervention was performed on any subjects for the purpose of the study. Data were collected retrospectively, by electronic medical record review. Human Ethics and Consent to Participate declaration is not applicable.

All the patients over the age of 18 years, that underwent bariatric surgery from January 2021 to February 2023 at BronxCare Hospital System, Icahn School of Medicine at Mount Sinai, New York, were considered in the study.

**Pre-operative data-**

Pertinent information collected included demographics, sleep study findings (Apnea-Hypopnea Index, minimum oxygen saturation, duration of desaturation), type of bariatric procedure, comorbidities such as hypertension (HTN), Type 2 Diabetes Mellitus (T2DM), Coronary Artery Disease (CAD) Cerebrovascular accident (CVA), atrial fibrillation (Afib), Major Depressive Disorder (MDD), pre-operative anthropometric measurements – weight (measured in kilograms – kg), and body mass index (BMI). Pre-operatively, certain laboratory parameters were collected- HbA1C, Serum cortisol, serum Thyroid Stimulating Hormone (TSH), Serum Vitamin D. Included patients underwent pre-operative Echocardiography and data on the Ejection Fraction (EF) and Pulmonary Artery Systolic Pressure (PASP), were collected. Included patients also underwent pre-operative Esophagogastroduodenoscopy (EGD). Data were collected on the EGD findings and Helicobacter pylori testing using Rapid Urease Test (CLO test- Campylobacter Like Organism test).

**Post-operative data-**

Post-operative anthropometric measurements of weight and BMI were noted at 6 months and 12 months.

**Calculations-**

Six values were calculated based on the pre- and post-operative anthropometric measurements - Excess Weight Loss % at 6 months (EWL6), Excess Weight Loss % at 12 months (EWL12) as per Eq. (1), Total Weight Loss % at 6 months (TWL6), Total Weight Loss % at 12 months (TWL12) as per Eq. (2), Change in BMI % at 6 months (Delta BMI 6) and change in BMI % at 12 months (Delta BMI 12) as per Eq. (3).

1) **Excess Weight Loss:**

\[
EWL = \frac{Preoperative \ weight - Postoperative \ weight \ (at \ 6 \ or \ 12 \ months)}{Pre-operative \ excess \ weight} \times 100
\]

2) **Total Weight Loss:**
3) Change in BMI:

\[
\text{Delta BMI} = \frac{\text{Preoperative BMI} - \text{postoperative BMI (at 6 or 12 months)}}{\text{Pre-operative BMI}} \times 100
\]

**Statistical analysis**

Data were analyzed using the STATA software. Mean values were calculated for all the numerical data. Chi square testing was applied to categorical variables. T test was applied for continuous variable. A p value of less than 0.05 was considered significant.

**Results**

A total of 122 bariatric surgeries were performed at the hospital in the study period. 108 patients out of the screened patients had a pre-operative sleep study. Preoperative weight data was not available for one patient in the OSA group. 6-month postoperative weight data was not available for 5 patients in the OSA group. 12-month postoperative weight data was not available for 21 patients in the OSA group and 7 patients in the non-OSA group. Analysis of anthropometric measures was accordingly done on the available data.

69.4% had OSA (75/108) and 30.6% (33/108) patients had no OSA. 45.3% (34/75) had mild OSA, 26.7% (20/75) had moderate OSA and 28% (21/75) had severe OSA. 88% of the participants were female (99/108). Mean age in the cohort was 41.9 +/- 10.8. 85.2% (92/108) of the total patients were Hispanic, 14% (15/108) were Black. There were no active smokers (15.7% former smokers and 84.3% never smokers).

Mean pre-operative weight was 111.2 +/- 20 kg in those without OSA and 115.9 +/- 22.6 kg in those with OSA. Mean preoperative BMI was 42.3 +/- 6.6 in the group without OSA and 44.5 +/- 15 in the group with OSA.

In the group without OSA, the respective TWL6 and TWL12 were 26.7 +/- 8.5 and 28.3 +/- 9.2 and in the group with OSA the respective values of TWL6 and TWL 12 were 26.8 +/- 13.6 and 31.1 +/- 16.2 (p value for TWL6 was 0.9 and for TWL12 was 0.4).

In the group without OSA, the respective EWL6 and EWL12 were 49.4 +/- 14.3 and 54.7 +/- 18.4 and in the group with OSA the respective values of EWL6 and EWL 12 were 44.9 +/- 13.9 and 51.7 +/- 15.7 (p value for EWL6 was 0.1 and for EWL12 was 0.5).

In the group without OSA, the respective Delta BMI 6 and Delta BMI 12 were 10.11 +/- 3.7 and 10.8 +/- 4.4 and in the group with OSA the respective values of Delta BMI 6 and Delta BMI 12 were 11.2 +/- 15.3 and
13.1 +/- 17.3 (p value for Delta BMI 6 was 0.7 and for Delta BMI 12 was 0.5).

Between the group without OSA and with OSA, no statistically significant difference was noted in the mean HbA1C (6.2 +/- 1.1 vs 6.1 +/- 1.1, p = 0.9), TSH (1.85 +/- 1 vs 2.3 +/- 2.3), serum cortisol (1.4 +/- 2.3 vs. 1.1 +/- 2.3, p = 0.7) Vitamin D (18.1 +/- 6.5 vs 21.4 +/- 9.2, p = 0.07), EF (65% +/- 5.9 vs 65% +/- 6, p = 0.8), PASP (36.8 +/- 9 vs. 40.2 +/- 8.3, p = 0.1), CLO test (45.5% vs. 43%, p = 0.8).

Abnormal EGD findings were seen in 54.6% (59/108) patient. In descending frequencies, the abnormal EGD findings were mucosal erythema in 29.6% (32/108), gastritis in 11.1% (12/108), hiatal hernia in 4.6% (5/108), gastric ulcer in 3.7% (4/108), gastric polyp in 2.7% (3/108), and esophagitis in 2.7% (3/108).

Active MDD requiring medication was seen in 7.4% (8/108) patients.

The results are presented below in Table 1. The types of surgeries performed are given in Table 2.
Table 1
Results. The mean values with the standard errors are provided in the table. Chi square testing was applied to categorical variables. T test was applied for continuous variable. A p value of less than 0.05 was considered significant. The test used to generate the p value is shown in parentheses next to each p value. c = Chi square test. t = T test.

<table>
<thead>
<tr>
<th></th>
<th>No OSA (33)</th>
<th>OSA (75)</th>
<th>Total (108)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>39 +/- 11.5</td>
<td>43.3 +/- 10.3</td>
<td>41.9 +/- 10.8</td>
<td>0.05 (t)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>32 (97%)</td>
<td>63 (84%)</td>
<td>95 (88%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 (3%)</td>
<td>12 (16%)</td>
<td>13 (12%)</td>
<td>0.06 (c)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>29 (88%)</td>
<td>63 (84%)</td>
<td>92 (85.2%)</td>
<td>-</td>
</tr>
<tr>
<td>Black</td>
<td>1 (3%)</td>
<td>0</td>
<td>1 (0.8%)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former smoker</td>
<td>6 (18%)</td>
<td>12 (16%)</td>
<td>18 (16.7%)</td>
<td>-</td>
</tr>
<tr>
<td>Never smoker</td>
<td>27 (82%)</td>
<td>63 (84%)</td>
<td>90 (83.3%)</td>
<td></td>
</tr>
<tr>
<td>Preop weight</td>
<td>111.2 +/- 20</td>
<td>115.9 +/- 22.6</td>
<td>114.7 +/- 21.6</td>
<td>0.3 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 74)</td>
<td>(n = 107)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preop BMI</td>
<td>42.3 +/- 6.6</td>
<td>44.5 +/- 15</td>
<td>43.9 +/- 13</td>
<td>0.4 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 74)</td>
<td>(n = 107)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWL 6</td>
<td>26.7 +/- 8.5</td>
<td>26.8 +/- 13.6</td>
<td>26.8 +/- 12.2</td>
<td>0.9 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 70)</td>
<td>(n = 103)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWL 12</td>
<td>28.3 +/- 9.2</td>
<td>31.1 +/- 16.2</td>
<td>30.2 +/- 14.3</td>
<td>0.4 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 26)</td>
<td>(n = 54)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EWL 6</td>
<td>49.4 +/- 14.3</td>
<td>44.9 +/- 13.9</td>
<td>46.4 +/- 14.1</td>
<td>0.1 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 70)</td>
<td>(n = 103)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EWL 12</td>
<td>54.7 +/- 18.4</td>
<td>51.7 +/- 15.7</td>
<td>52.6 +/- 16.6</td>
<td>0.5 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 26)</td>
<td>(n = 54)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delta BMI 6</td>
<td>10.11 +/- 3.7</td>
<td>11.2 +/- 15.3</td>
<td>10.8 +/- 12.8</td>
<td>0.7 (t)</td>
</tr>
<tr>
<td></td>
<td>(n = 70)</td>
<td>(n = 103)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1

<table>
<thead>
<tr>
<th></th>
<th>No OSA (33)</th>
<th>OSA (75)</th>
<th>Total (108)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta BMI 12</td>
<td>10.8 +/- 4.4</td>
<td>(n = 26)</td>
<td>13.1 +/- 17.3</td>
<td>(n = 54)</td>
</tr>
<tr>
<td>HbA1c</td>
<td>6.2 +/- 1.1</td>
<td></td>
<td>6.1 +/- 1.1</td>
<td></td>
</tr>
<tr>
<td>TSH</td>
<td>1.85 +/- 1</td>
<td></td>
<td>2.3 +/- 2.3</td>
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</tr>
<tr>
<td>Cortisol</td>
<td>1.4 +/- 2.3</td>
<td></td>
<td>1.1 +/- 2.3</td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>18.1 +/- 6.5</td>
<td>(n = 26)</td>
<td>21.4 +/- 9.2</td>
<td>(n = 54)</td>
</tr>
<tr>
<td>HTN</td>
<td>11 (33.3%)</td>
<td></td>
<td>26 (34.6%)</td>
<td></td>
</tr>
<tr>
<td>T2DM</td>
<td>8 (24.24%)</td>
<td></td>
<td>16 (21.3%)</td>
<td></td>
</tr>
<tr>
<td>CVA</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>CAD</td>
<td>1 (3%)</td>
<td></td>
<td>1 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Afib</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>3 (9.1%)</td>
<td></td>
<td>5 (6.7%)</td>
<td></td>
</tr>
<tr>
<td>EF</td>
<td>64.98 +/- 5.9</td>
<td>(n = 26)</td>
<td>65.2 +/- 6</td>
<td></td>
</tr>
<tr>
<td>RVSP</td>
<td>36.8 +/- 9</td>
<td></td>
<td>40.2 +/- 8.3</td>
<td></td>
</tr>
<tr>
<td>Clo test</td>
<td>15 (45.5%)</td>
<td></td>
<td>32 (42.6%)</td>
<td></td>
</tr>
<tr>
<td>EGD</td>
<td>22 (66.6%)</td>
<td></td>
<td>38 (50.7%)</td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td>11 (33.3%)</td>
<td></td>
<td>37 (49.3%)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Types of Surgery.

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robotic gastric sleeve resection</td>
<td>91/108 (84.26%)</td>
</tr>
<tr>
<td>Robotic Roux en Y gastric bypass</td>
<td>8/108 (7.41%)</td>
</tr>
<tr>
<td>Laparoscopic sleeve gastrectomy</td>
<td>6/108 (5.56%)</td>
</tr>
<tr>
<td>Revision</td>
<td>2/108 (1.85%)</td>
</tr>
<tr>
<td>Laparoscopic Roux en Y gastric bypass</td>
<td>1/108 (0.93%)</td>
</tr>
</tbody>
</table>

Discussion
In eligible patients, bariatric surgery results in substantial weight loss. In a study on individuals between age 20 and 64 in NHANES comparing individuals who had bariatric surgery with those who were eligible for it, but did not get surgery, it was found that post-bariatric surgery, there is five times more likelihood of achieving at least 20% weight loss. Participants who had surgery had a reduction of 15.5 BMI units and a 31% weight loss compared to 4.4 BMI units and 9.9% weight loss in the eligible but not operated group. 86.2% of the operated patients achieved 20% weight loss compared to 15.3% of the non-operated group [6]. Most patients in our study (84.26%) underwent robotic gastric sleeve resection.

Factors that have been implicated as being impactful in post-operative weight loss include age, race, socioeconomic status, gender, marital status, behavioral disorders, pre-operative weight status, comorbidities such as diabetes mellitus, psychiatric illness, and sexual abuse, and institutional differences etc. Only a few are consistently supported in literature [7].

In our review, we found a few studies that looked at OSA as a predictor of post-bariatric surgery weight loss. In the larger of the studies by de Raaff et al, 816 patients were analyzed retrospectively. Out of these, 522 (64%) had OSA and 294 (36%) did not have OSA. The study was aimed at evaluating the impact of OSA on % EWL at 12 months and BMI changes at 12 months after bariatric surgery. No information about ethnicity was available in the article. After adjustment for waist circumference, BMI, and age, no effect of OSA was seen on either the %EWL or BMI change at the end of 12 months [8]. In another study on a similar topic, Guggino et al analyzed 371 patients included in a prospective cohort, the Severe Obesity Outcome Network cohort. 210 out of these had moderate – severe OSA, and 161 had no OSA. Multivariable analysis of the data showed that age, initial BMI, and surgery type were associated with differences in % EWL. OSA independently, was not shows to be associated with % EWL [9]. In a similar study by Mihalache et al. The authors analyzed a bariatric population that underwent laparoscopic sleeve gastrectomy. The primary outcome was % body fat change at 6 months and 12 months. The study revealed that patients with OSA had lesser loss of body fat as compared to patients without OSA. The weight loss experienced by both group of patients was the same. All participants in this study were Caucasian [10]. In our study, we noted a similar lack of difference in the weight loss attained between patients with and without OSA at the end of 6 and 12 months.

Prevalence of DM ranges from 6.6% in patients without OSA to 28.9% in patients with severe OSA, thus showing an increase with severity [11]. OSA results in sleep fragmentation and intermittent hypoxemia, which in turn lead to increased sympathetic neural activity, oxidative stress, systemic inflammation, activation of hypothalamic pituitary axis and alternation of circulating adipokines. These result in insulin resistance and beta cell dysfunction culminating to diabetes. Even in patients without T2DM, severity of OSA has been shown to be independently associated with insulin resistance. In reverse, the neuropathy that DM induces, can affect the central control of respiration and upper airway neural reflexes. This can lead to emergence of sleep apnea. Hence, the relationship between OSA and DM has been cited as being bi-directional [12]. Bariatric surgery results in improvement in obesity and drop in AHI. This is thought to be beneficial in the control of DM [12]. The American Society of Metabolic and Bariatric Surgery (ASMBS) now recommends bariatric surgery for individuals with BMI of 30-34.9 with metabolic disease including...
hyperglycemia that does not respond to non-surgical options [13]. In our study, no significant difference was noted in the A1C levels or the prevalence of diabetes mellitus in the two groups.

Hypothyroidism is associated with OSA. Deposition of muco-proteins in the upper airway resulting in upper airway obstruction, neuropathy induced disruption of the regulatory control of pharyngeal dilator muscles and respiratory center depression have been cited as possible causes of OSA in hypothyroidism. Prevalence of hypothyroidism in OSA is low (0.4%), but subclinical hypothyroidism seems to be more common in OSA (11.1%) [14]. TSH levels are positively correlated with BMI [15]. In our study we noted that the mean TSH level in the OSA group was higher than the non-OSA group, although the difference did not reach statistical significance (2.3 +/- 2.3 vs 1.85 +/- 1).

A meta-analysis from 2023 including 5592 individuals from 18 observational studies found a lower levels of Vitamin D in patients with OSA compared to those without (18.2 +/- 5.6 ng/ml vs. 23.2 +/- 4.3 ng/ml). The effect was significant only in people with moderate to severe OSA, and not in mild OSA [16]. Similarly, another meta-analysis, reveals a 35% higher prevalence of vitamin D deficiency in obese subjects [17]. Perceiption of low social acceptance leading to decreased outdoor activities and increased use of clothes to cover more body is one theory cited to explain vitamin D deficiency in the obese. Sequestration of cholecalciferol by excess fat, and greater local use of 25 (OH)D are other theories in obese individuals [17]. Hypoxia induced in OSA is related to vitamin D deficiency via HIF 1 alpha (Hypoxia inducible factor 1 alpha) [16]. There was no significant difference in the vitamin D levels between the 2 groups in our study. One of the possibilities for this, could be the smaller number of severe OSA patients in our study.

In many centers esophagogastroduodenoscopy is routinely performed before bariatric surgery, the rationale behind this being that the bariatric procedure might alter the foregut anatomy. Gomez et al analyzed 232 patients cleared to undergo bariatric surgery, and noted abnormal findings in 61.6% patients, with 15.1% requiring medical management alterations and 1.7% requiring alterations in surgical management. The commonest finding on EGD was a small hiatal hernia (23.7%) [18]. In our study, the commonest EGD finding was erythematous mucosa.

A few studies have demonstrated association between OSA and H pylori, whereas others have not [19] [20] [21]. In our study the prevalence of H pylori infection was found to be 43% in the total cohort, with no statistically significant difference between the two groups. However, this is higher than the average H pylori prevalence of 36% in the country [22].

OSA is linked with pulmonary hypertension [23]. The mean Pulmonary Artery Pressure increases during OSA. The OSA patient performs a series of inspiratory efforts against a completely obstructed upper airway. These can last from 10 seconds to 2 minutes with negative pleural pressures that can go up to -60 mmH2O before resumption of ventilation. Such sleep related events result in hypoxemia, hypercapnia, variations in intrathoracic pressure and arousals associated with sympathetic upswings. The consequent changes in vascular tone and cardiac output modify the pulmonary artery pressure. Pulmonary Hypertension (PH) due to lung diseases is classified as group 3 PH [24]. Independent of OSA, obesity has been linked with pulmonary hypertension as well [25]. Two parameters were recorded on
echocardiography in our bariatric population- Ejection Fraction (EF) and PASP (Pulmonary Artery Systolic Pressure), both showing no significant difference.

OSA is a known risk factor for HTN [26], T2DM [11], CAD [27], CVA [28], Atrial fibrillation [29] and MDD [30]. Difference was not noted in any of these diseases.

The study has certain limitations. The behavioral changes such as increased sedentary lifestyle and reduced physical exertion as a result of the coronavirus pandemic, might have affected the findings in the study. This was a single center study. Post-operative data was available only for weight and BMI, and not for other metabolic parameters such as A1C, TSH, cortisol, Vitamin D etc.

We noted the following major strengths of this study. Majority of the patients in this study were Hispanic. The population was predominantly from the inner-city area. This population is underserved and has traditionally not been well studied.

Conclusions

No significant differences exist between patients with or without OSA, who qualify for bariatric surgery, either in pre-operative anthropometric or lab characteristics. Post-operatively, there exists no difference in the amount of weight loss achieved between patients with or without OSA.

Abbreviations

Afib- Atrial Fibrillation
BMI- Body Mass Index
CAD- Coronary Artery Disease
Campylobacter Like Organism test - CLO test
CVA- Cerebrovascular accident
EF- Ejection Fraction
EGD- Esophagastroduodenoscopy
EWL 6 %- Excess Weight Loss % at 6 months
EWL 12 %- Excess Weight Loss % at 12 months
HTN- Hypertension
Kg - kilograms
MDD- Major Depressive Disorder
OSA- Obstructive Sleep Apnea

PASP- Pulmonary Artery Systolic Pressure

T2DM - Type 2 Diabetes Mellitus

TSH- Thyroid Stimulating Hormone

TWL 6 % - Total Weight Loss % at 6 months

TWL 12 % - Total Weight Loss % at 12 months

Declarations

Competing interests:

The authors declare no competing interests.

Author Contribution

Preparation of manuscript was done by A.J. Figures and tables were prepared by A.J. Data collection and tabulation was done by A.J, J.M, L.R.P. All authors were involved in the review of manuscript.

Acknowledgement

Dr Gilda Diaz-Fuentes for valuable inputs. Pravash Budhathoki and Siddarth Hanumanthu for tabulation and statistical analysis.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References


2023


17. Pereira-Santos, M. Costa, PRF. Assis, AMO. Santos, CAST. Santos, DB. Obesity and vitamin D deficiency a systematic review and meta-analysis. Obesity Reviews, 16 (4), 2015.


Figures
Figure 1

Distribution of patients. OSA = Obstructive Sleep Apnea. Out of 122 patients who underwent bariatric surgery, 14 patients had no sleep study. 108 patients were included in the final analysis, of which 75 had OSA and 33 did not. Severe, moderate and mild OSA were seen in 34, 20 and 21 patients respectively.