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# Prevalence and Severity of Sleep Apnea in a Group of Morbidly Obese Patients

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**Background: Obesity is the most important risk factor for obstructive sleep apnea. It is estimated that 70% of sleep apnea patients are obese. In the morbidly obese, the prevalence may reach 80% in men and 50% in women. The aim of this study was to determine the prevalence and severity of sleep apnea in a group of morbidly obese patients, leading to bariatric surgery.**

**Methods: In a cross-sectional study developed in Bahia, northeastern Brazil. 108 patients (78 women and 30 men) from the Obesity Treatment and Surgery Center - "Núcleo de Tratamento e Cirurgia da Obesidade" underwent standard polysomnography. Patients with an apnea-hypopnea index (AHI) ≥5 events/hour were considered apneic.**

**Results: Mean ± SD for age and BMI were 37.1 ± 10.2 years and 45.2 ± 5.4 kg/m$^2$, respectively. The calculated AHI ranged widely from 2.5 to 128.9 events/hour. Sleep apnea was detected in 93.6% of the sample, wherein 35.2% had mild, 30.6% moderate and 27.8% severe apnea. Oxyhemoglobin desaturation was directly related to the AHI and was more severe in men.**

**Conclusion: There was a high frequency of sleep apnea in this group of morbidly obese patients, for whom it was very important to request polysomnography, thus enabling therapeutic management and prognostication.**

*Key words*: Oxyhemoglobin desaturation, morbid obesity, obesity surgery, polysomnography, apnea-hypopnea index

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## Introduction

Obesity is a growing epidemic and is rapidly becoming a serious public health problem in modern societies. Obesity presents increased risk for a series of chronic diseases, among them diabetes mellitus, dyslipidemia, cardiovascular disease and obstructive sleep apnea (OSA).[1]

Obstructive sleep apnea/hypopnea syndrome is a condition characterized by repeated episodes of upper airway obstruction during sleep, usually associated with interrupted sleep and oxyhemoglobin desaturation.[2]

According to Young et al,[3] OSA affects 4% of men and 2% of women from ages 30 to 60 years. Obesity is the most important risk factor for this condition, and it is estimated that 70% of sleep apnea patients are obese.[4,5] In the morbidly obese, the prevalence may reach 80% in men and 50% in women.[6]

OSA affects the conduct of anesthesia and makes peri- and postoperative management difficult, prolongs hospitalization and is associated with the occurrence of complications after bariatric surgery.[7-10]

The aim of this study was to assess the frequency and severity of OSA in a group of morbidly obese patients referred for bariatric surgery and to investigate the indication for preoperative polysomnography.

## Materials and Methods

Our cross-sectional study included 108 morbidly obese patients who attended the obesity treatment and surgery center "Núcleo de Tratamento e Cirurgia da Obesidade – NTCO", a subdivision of Portuguese Hospital in Salvador, Bahia, Northeastern Brazil. Polysomnography was randomly performed at either the Cardio Pulmonar Institution or the Otorhino Center during the period of March 2003 to October 2005. During this interval, 163 patients were referred to the sleep laboratories, and only those with BMI ≥40 kg/m$^2$ were included in the study. Both centers had the same type of polysomnography and the report was issued by the same observer.

The present study was approved by the Ethics Committee for Research in Human Beings from Portuguese Hospital.

The data were obtained from the patient case history cards (NTCO), the pre-sleep questionnaire (applied routinely by sleep laboratories) and from polysomnography.

Weight and height were measured on an electronic scale (DIGIPESO®), with the patient situated in the center of the platform, dressed, but without shoes. The body mass index (BMI) was calculated as kg/m$^2$.[11]

Daytime somnolence was quantified by the Epworth sleep Scale. Scores ≥10 were indicative of excessive somnolence.[12]

Polysomnographs were performed by computerized equipment from Medtron Sonolab 620 (São Paulo, Brazil), and the reports were issued by one of the authors in accordance with the Rechtschaffen and Kales criteria.[13] The polysomnographic examination was conducted throughout the entire night, during which the following parameters were recorded: electroencephalogram (electrodes C3, C4, O1, O2), oculogram, electromyogram (electrodes in the mental, submental and regions of the inferior limbs), electrocardiogram, air-flow (thermistor/nasal cannula), respiratory effort (thoracic and abdominal belt), snoring (microphone on the chin) and body position (sensor on the thoracic belt). Oxyhemoglobin saturation was measured by wrist oximetry, a form of pulse-oximetry ($SpO_2$, %). The respiratory events were defined as follows: 1) apnea – air-flow interruption for 10 seconds or longer and 2) hypopnea – a reduction of 50% or more in the inspiratory air-flow and/or abdominal movements for a period ≥10 seconds, associated with a decrease of over 4% in oxyhemoglobin saturation and/or a micro-awakening. Mixed apneas were also included in the Apnea-Hypopnea Index (AHI), and were defined as those that presented absence of respiratory effort in the beginning of the period, followed by its gradual increase. AHI was obtained by means of polysomnographic examination, wherein the total number of respiratory events is divided by the hours of sleep (ev/h).[2] The patients were classified in accordance with the AHI as follows: no apnea – fewer than 5.0 events/hour of sleep (ev/h); light apnea – 5.0 and 14.9 ev/h; moderate apnea – 15.0 and 30.0 ev/h; and severe apnea – >30.0 ev/h.[2] The number of micro-awakenings was calculated by dividing the total number of events during sleep by the hours of sleep.

### Data Analysis

The program Statistical Package for Social Science (SPSS, Inc, Chicago, IL, version 9.0. 1998) was applied for statistical analysis.

The results of the continuous variables were presented in the form of mean ± standard deviation (± SD), added to the median (Md) and interquartile range (IQR) when the variable did not have a normal distribution. The variable categories were expressed as ratios. For comparison of the continuous variables between two groups, the Student *t*-test for independent samples or the Mann-Whitney test was used. For the analysis of three or more groups, the one-way analysis of variance – ANOVA or Kruskal-Wallis was used, as appropriate, with Bonferroni or Mann-Whitney two by two, respectively, having been applied as post-tests. To study the correlations between the variables, the Pearson's or Spearman's test of correlation was used, in accordance with the distribution of the variable. The value of $P < 0.05$ was considered statistically significant.

## Results

A total of 108) morbidly obese patients, ranging from 21 to 64 years of age, with average age 37.1 ± 10.2 years,

were assessed, of whom 78 (72.2%) were women. Table 1 presents the patients' general characteristics.

BMI ranged from 40.0 to 69.7 kg/m$^2$ with a mean value of 45.2 ± 5.4 kg/m$^2$. There was no statistically significant difference between the mean BMI of men and women (44.9 ± 4.3 versus 45.3 ± 5.8 kg/m$^2$; *P*=0.848)

The Epworth score ranged from 1 to 16 with a mean value of 7.8 ± 3.5, and 30.2% of the patients presented excessive somnolence. Among them, 96.9% had OSA, and among the OSA patients, 31.3% had excessive somnolence.

A great variation in AHI was observed, from 1.5 to 116.0 with a mean value of 25.8 ± 24.1 ev/h (Md: 18.6; IQR: 8.7 – 34.2 ev/h). Of the 108 patients studied, it was observed that 101 (93.6%) demonstrated AHI ≥ 5 ev/h. Among the patients with sleep apnea, 38 (35.2%) demonstrated light apnea, 33 (30.6%) moderate and 30 (27.8%) severe apnea. When the genders were analyzed separately, the mean AHI was observed to be much higher in men (41.3 ± 28.3; Md: 37; IQR: 18.3 – 58.2 ev/h) as compared to women (19.9 ± 19.4; Md: 14.4; IQR: 8.0 – 23.1 ev/h; *P*<0.001). The frequency of OSA was 96.7% in men and 92.3% in women (*P*=0.698); although this difference did not attain statistical significance, it was observed that the percentage of men with severe apnea was much greater than that of women (58.6% versus 18.1%; *P*=0.0001).

The number of micro-awakenings varied from 1.4 to 113.0 with a mean value of 16.1 ± 14.4 ev/h (Md: 12.8; IQR: 7.3 – 19.7 ev/h) being higher in men (17.8 ± 11.1; Md: 14.8; IQR: 11.6 – 21.4 ev/h) than in women (15.5 ± 15.5; Md: 11.6; IQA: 6.9 – 17.2 ev/h) (*P*=0.049). Snoring was observed in 92.5% of the patients.

Oxygen saturation was stratified as follows: basal, medium and minimum saturations. Basal $SpO_2$ ranged from 87.4 to 100% with a mean value of 96.3 ± 1.6%. Medium $SpO_2$ ranged from 88.1 to 97.3% with a mean value of 94.4 ± 1.7%. Whereas minimum $SpO_2$ ranged from 51 to 93% with a mean of 79.3 ± 8.8%, 50% of the patients in this category presented minimum $SpO_2$ below 81%. During polysomnographic recording, it was observed that 91.7% of the patients spent from 0.1 to 52.7% (mean of 6.8 ± 10.3; Md: 2.3%; IQR: 0.4 – 8.7%) of the total sleep time with $SpO_2$ below 90%. Over 45% (45.3%) of the patients spent from 0.1 to 18.6% (mean 0.7 ± 2.4%; Md: 0%; IQR: 0.0 – 0.4%) of the total sleep time with $SpO_2$ below 80%. When oxygen saturation was stratified by gender, it was observed that there was no statistically significant difference in basal saturation between men and women (96.0 ± 2.0% versus 96.4 ± 1.4%; *P*=0.438). However, men were found to have lower mean $SpO_2$ than women (93.0 ± 1.9 versus 94.9 ± 1.3%; *P*<0.001), respectively, as well as minimum $SpO_2$ (73.7 ± 1.7 versus 81.5 ± 0.9%; *P*<0.001).

When studying the correlation between the researched variables, stronger correlation was found between AHI and minimum $SpO_2$ , confirming that the more severe the OSA, the greater the oxyhemoglobin desaturation (Table 2).

As regards co-morbidities of the 108 patients, 51 (47.2%) presented one or more co-morbidities, the most frequent being systemic arterial hypertension (38; 35.2%), arthritis (17; 15.7%) and diabetes mellitus (8; 7.4%).

**Table 1. Characteristics of the 108 morbidly obese patients** (Values expressed in mean ± SD, or median and IQR [interquartile range] when appropriate)

| Characteristics | Results |
|---|---|
| Women | 78 (72.2%) |
| Age (years) | 37.1 ± 10.2 |
| BMI (kg/m$^2$) | 45.2 ± 5.4 |
| Epworth scale | 7.8 ± 3.5 |
| IAH (ev/h) Md (IQR) | 18.6 (8.7 – 34.2) |
| Basal $O_2$ saturation (%) | 96.3 ± 1.6 |
| Mean $O_2$ saturation (%) | 94.4 ± 1.7 |
| Minimum $O_2$ saturation (%) | 79.3 ± 8.8 |
| Micro-awakenings Md (IQR) | 12.8 (7.3 – 19.7) |
| Snoring | 92.5% |

**Table 2. Correlation between the variables studied in the 108 obese patients**

| Correlations | r | *P* |
|---|---|---|
| BMI vs AHI | 0.227 | 0.018 |
| Basal $SpO_2$ vs AHI | -0.161 | 0.097 |
| Mean $SpO_2$ vs AHI | -0.556 | <0.0001 |
| Minimum $SpO_2$ vs AHI | -0.580 | <0.0001 |
| Micro-awakenings vs basal $SpO_2$ | -0.108 | 0.264 |
| Micro-awakenings vs mean $SpO_2$ | -0.260 | 0.010 |
| Micro-awakenings vs minimum $SpO_2$ | -0.286 | 0.003 |

Alterations in the number of micro-awakenings and in $O_2$ desaturation were associated with the severity of sleep apnea. The data showed that the more severe the OSA, the higher the number of micro-awakenings, desaturations and the lower the $SpO_2$ (Table 3).

## Discussion

The present study data showed a high frequency of sleep apnea in a group of morbidly obese patients referred for bariatric surgery, and it was observed that severe apnea was more frequent in men. The results showed a strong negative correlation between AHI and minimum $SpO_2$ and that 50% of the patients presented minimum $SpO_2$ <81%. Furthermore, it was observed that the mean and minimum saturations were lower in men, despite the fact that both genders had similar BMI.

By means of a sleep questionnaire, Peiser et al[14] assessed 371 morbidly obese patients referred for bariatric surgery and selected those who presented with snoring, excessive somnolence and non-reparative sleep to undergo polysomnography. Fifteen patients (14 men and 1 woman) with mean age 44.9 ± 10.1 years were studied, OSA being confirmed in 90% of the suspected subjects. Van Boxem and de Groot[15] studied 48 morbidly obese patients (19 men and 29 women) referred to their clinic, and reported that 39.6% of the patients had AHI ≥5 ev/h. They also observed that men demonstrated higher AHI (18.4 ± 20.9 versus 4.8 ± 9.4) and greater oxyhemoglobin desaturation. In their series, no woman demonstrated severe apnea. By means of polysomnography, Rajala et al[16] studied 27 morbidly obese patients (BMI ≥40 kg/m$^2$) with a mean age of 36.9 ± 8.2 years, 13 being men and 14 women. They found a total prevalence of OSA of 40.7%, which, despite similar BMIs, was more frequent in men than in women (76.9% versus 7.1%). Valencia-Flores et al[17] evaluated OSA prevalence and electrocardiographic alterations in 52 morbidly obese patients (39 women and 13 men) with a mean age of 40 ± 12 years and BMI 51 ± 9 kg/m$^2$. They observed that 51 (98%) of the patients demonstrated AHI ≥5 ev/h. It was concluded that the risk for cardiac arrhythmias increased in the presence of severe apnea (AHI ≥65) and $SpO_2$ <65%. Frey and Pilcher[18] investigated respiratory sleep disturbances in 41 morbidly obese patients (BMI 47 kg/m$^2$), the majority of whom were women. They found a prevalence of 71% OSA and 17% upper airway resistance syndrome without apnea.

**Table 3. Clinical and polysomnographic parameters of the morbidly obese in accordance with sleep apnea severity**

| Characteristics | Light Apnea n = 38 | Moderate Apnea n = 33 | Severe Apnea n = 30 |
|---|---|---|---|
| Age (years) | 36.5 ± 9.8 | 37.4 ± 10.1 | 38.9 ± 10.9 |
| BMI (kg/m$^2$) | 44.2 ± 3.8 | 45.9 ± 6.5 | 46.3 ± 6.1 |
| Basal $SpO_2$ (%) | 96.6 ± 1.0 | 96.3 ± 1.2 | 95.8 ± 2.4 |
| Mean $SpO_2$ (%) | 95.2 ± 1.4 | 94.4 ± 1.3 | 94.3 ± 1.8* |
| Minimum $SpO_2$ (%) | 83.9 ± 5.8 | 78.0 ± 8.2 | 73.0 ± 9.1† |
| Time $SpO_2$ < 90% (min) Md (IQR) | 2.0 (0.8 – 6.4) | 10.3 (3.4 – 21.5) | 29.5 (12.5 – 72.3) ‡ |
| Time $SpO_2$ < 80% (min) Md (IQR) | 0.0 (0.0 – 0.0) | 0.3 (0.0 – 1.6) | 1.0 (0.0 – 6.3) § |
| No. of desaturations Md (IQR) | 4.0 (2.0 – 14.0) | 32.0 (14 – 48.5) | 76.0 (33.0 – 142.5)¶ |
| No. of micro-awakenings Md (IQR) | 8.4 (6.3 – 13.4) | 14.4 (6.8 – 16.5) | 20.8 (16.2 – 32.2) # |

$SpO_2$=oxygen saturation; Md=median; IQR=interquartile range.
* Light vs moderate apnea, *P*=0.016; light vs severe, *P*<0.001; moderate vs severe, *P*=0.006.
† Light vs moderate apnea, *P*=0.002; light vs severe, *P*<0.001; moderate vs severe, *P*=0.043.
‡ Light vs moderate apnea, *P*=0.002; light vs severe, *P*<0.001; moderate vs severe, *P*=0.003.
§ Light vs moderate apnea, *P*=0.001; light vs severe, *P*<0.01; moderate vs severe, *P*=0.128.
¶ Light vs moderate apnea, *P*=0.001; light vs severe, *P*<0.001; moderate vs severe, *P*=0.001.
# Light vs moderate apnea, *P*=0.058; light vs severe, *P*<0.001; moderate vs severe, *P*=0.001.

The present study differs from the others with regard to a greater frequency of sleep apnea, both in absolute percentage of patients and in women. Nevertheless, it is interesting to note that our study's results are close to those of Valencia-Flores et al[17] who also studied a group of Latin subjects. The limitations of our study were the problems in diagnosing hypopnea. Different criteria for defining hypopnea and the type of oximeter are examples that may affect AHI and consequently the degree of OSA.[19,20]

Various articles approach the difficulties in managing OSA patients during and after surgical procedures. Deutzer[8] points out that anesthetic and analgesic agents increase the severity of OSAHS symptoms after gastric bypass, and that these patients must be treated with continuous positive airway pressure (CPAP) in the immediate postoperative period. In a study of 188 patients subjected to gastric bypass, Perugini at al[10] identified the surgeon's experience, the presence of sleep apnea and arterial hypertension as predictors of complications after surgery. In a larger study of 311 obese patients subjected to gastric bypass, Ballantyne et al[7] found that, in addition to OSA, five other predictors of prolonged hospital stay were identified: open surgical procedure, BMI >60 kg/m$^2$, duration of surgery >120 minutes, asthma, and hypercholesterolemia.

O'Keeffe and Patterson[21] studying 170 obese patients referred for bariatric surgery, observed that only 26 (15.3%) were diagnosed as having OSA before the surgical consultation. Of the 137 patients who were subjected to polysomnography, 105 (76.6%) were diagnosed as having OSA. The authors concluded that OSA was not diagnosed in the majority of the patients before surgery, and this data supports the indication of polysomnography as a routine evaluation before bariatric surgery.

Tung and Rock[22] suggested that the peri-operative treatment and diagnosis of OSA would result in less postoperative sleep deprivation, better response to the respiratory depressive effects of analgesic and anesthetic drugs and normalization of cardiovascular disturbances. In the preoperative phase, the goal is to diagnose and evaluate the degree of co-morbid conditions associated with sleep apnea, such as obesity, hypertension, coronary artery disease, cerebrovascular disease and pulmonary hypertension.

Dexmedetomidine is a selective central alpha2 agonist with sedative, pro-anesthetic and pro-analgesic effects. It minimizes opioid-induced muscle rigidity, lessens postoperative shivering, causes minimal respiratory depression, and has hemodynamic stabilizing effects.[23] It has been used in bariatric surgery to reduce postoperative pain requirements and has shown a significant decrease in the use of narcotics and respiratory suppression.[24-26]

In the present study, it was concluded that the frequency of sleep apnea in this morbidly obese group was very high, which justifies investigation of this pathology in these patients, particularly before being subjected to bariatric surgery.

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