Women and the Obstructive Sleep Apnea Syndrome*

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Twenty-seven women referred to a sleep disorders clinic for symptoms of obstructive sleep apnea syndrome (OSAS) during one year were systematically analyzed after polygraphic monitoring of sleep and cephalometric x-ray examination. Our subjects, one-third of whom were premenopausal, comprised approximately 12 percent of the total OSAS population seen. Women with OSAS were compared with 110 OSAS men and with a group of 16 women without OSAS but referred to orthodontists for mild dental malocclusion. Women with OSAS were massively obese, much more so than their male counterparts. There was no significant difference between pre- and postmenopausal women, with the exception of the respiratory disturbance index (RDI), which was lower in the postmenopausal group despite similar morbid obesity (seemingly better tolerated by women with OSAS than by men with the same syndrome) and long mandibular plane-hyoid bone distance. The significantly higher RDI noted in premenopausal women, despite equally massive obesity and upper airway abnormalities, is thought to be related to hormonal status and better arousal response. Chronic obstructive lung disease (COLD) seen in a subgroup of women with OSAS did not differentiate this subgroup from the other OSAS patients when oxygen saturation during sleep, frequency of abnormal respiratory events and sleep variables were considered. Massive obesity is the dominant factor for the appearance of OSAS in women.

Surveys of obstructive sleep apnea syndrome (OSAS) have frequently emphasized the male predominance of the syndrome. However, women appear to be increasingly susceptible to heavy regular snoring and OSAS after menopause. Both pre- and postmenopausal women with OSAS are seen in sleep disorders clinics. This report analyzes features presented by OSAS women and compares the data with that obtained for a control group of nonOSAS women and for OSAS men during the same time period.

Materials and Methods

Patient Population

All patients were seen in a sleep disorders clinic and were referred for one of the following complaints: excessive daytime sleepiness (EDS), disrupted nocturnal sleep, heavy snoring at night, or suspicion of OSAS. To enter the study, patients had to be at least 18 years of age and have a polygraphically-defined respiratory disturbance index (RDI) ≥10. All patients must have been clinically evaluated by a sleep clinic physician and have been seen during a 12-month time period. None of the OSAS women meeting the above pre-selected criteria was eliminated from the study. The OSAS men used for comparison were similarly selected but only had to be seen during a six-month time segment overlapping the women’s 12-month time period. The recruitment period for the men’s OSAS group was shortened to avoid having a too-large difference in numbers between the two groups, since many more men than women present with this disturbance. The required criteria were met by 110 men.

Finally, a control population focusing on the presence of mild mandibular retroposition was recruited. It consisted of 16 women who had consulted orthodontists for a mild to moderate dental malocclusion syndrome with overjet, had no symptoms of OSAS, and, independent of their weight, had an RDI <5 at nocturnal ambulatory monitoring using the Vitalog equipment recorder, which is based on calibrated inductive respiratory plethysmography. This control population was specifically recruited through orthodontists, as retroposition of the mandible has been implicated in the appearance of OSAS, and we wished to compare OSAS women with women presenting a known mild mandibular problem. No woman who agreed to be a control subject and to have ambulatory monitoring for one night was eliminated.

The 27 OSAS women had a mean age of 47.8 ± 12.8 years, range 18 to 66; nine were premenopausal. The 110 OSAS men had a mean age of 49.0 ± 11.4 years, range 24 to 74, and the 16 control women had a mean age of 27 ± 7.2 years, range 19 to 42; all were premenopausal.

Study Design

All patients had one night of polygraphic monitoring and cephalometric roentgenograms as part of the protocol. Control subjects underwent cephalometric roentgenographic examination and only one night of nocturnal ambulatory monitoring, as indicated.

The variables monitored during polygraphic recording were electroencephalogram, electro-oculogram, chin electromyogram and electrocardiogram (modified V1 lead). Respiration was monitored by uncalibrated inductive respiratory plethysmography; airflow was monitored by thermistors; and oxygen saturation by ear oximeter. Apnea, hypopnea and sleep stages were scored according to standard definitions based upon findings obtained from respiratory, airflow, oximetric and other channels. Hypopnea was defined as 1) a 50 percent reduction in maximal thermistor output compared with baseline, and 2) association with a decrease in oxygen saturation to below 92 percent from a baseline of at least 94 percent, or a drop in oxygen saturation of at least 3 percent if baseline was below 90 percent. The RDI ([apnea + hypopnea] × 60/total sleep time [TST]), which takes into account the number of abnormal breathing events per hour of sleep, was calculated. Two oxygen saturation indices were also calculated. We arbitrarily considered as "significant" a desaturation below 90 and 80 percent. From the relationship of the <90 percent and the <80 percent levels of oxygen desaturation to an apnea or hypopnea and the number of oxygen drops below 90 or 80

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percent calculated per hour of sleep, we formulated two indices indicating the frequency of drops of oxygen saturation below 90 or 80 percent per hour of sleep: O$_2$-90-I and O$_2$-80-I. Sleep was scored in 30-s epochs following the international criteria of Rechtschaffen and Kales. Body mass index (BMI) (weight/10,000 × height$^2$) was calculated by the method of Khosla and Lowe.

Lateral cephalometric roentgenograms were obtained with the Werner cephalostat using the technique reported by Riley et al. Tracings of the roentgenograms were made on an acetate sheet by an investigator blind to nocturnal polygraphic results. The following angles and dimensions in millimeters were measured on the flat film: SNA = angle measurement from sella (S), nasion (N), subspinale (point A); SNB = angle measurement from sella (S), nasion (N), supramentale (point B); MP-H = distance from mandibular plane to hyoid bone (in mm); PNS-P (palate) = distance from posterior nasal spine to the tip of the soft palate (in mm); PAS = posterior airway space (in mm), defined as the space behind the base of the tongue (Fig 1). Normative values used to compare cephalometric roentgenogram measurements obtained on our OSAS and control populations were those published on cephalometric landmarks and evaluations of cranio-facial anomalies. As textbooks often do not dissociate men from women, we also compared our OSAS women with women treated by orthodontists for mild overjet without evidence of OSAS.

Recent pulmonary function tests and blood gas levels recorded for patients awake and seated were obtained. All patients were in stable condition at the time of the spirometric study. Three variables are usually selected to define COLD: ratio of residual volume to total lung capacity, maximal mid-expiratory flow, and forced expiratory volume in one second expressed as the percentage of forced vital capacity (FEV/FVC). Considering the obesity factor, the literature, and the definition of COLD, we decided to select FEV/FVC for the purpose of the study as it is the only variable of the three not affected by marked obesity. COLD was considered present if results indicated <80 percent at 20 years of age and <70 percent at 70 years of age.

Alcohol intake was also evaluated. "Regular alcohol intake" was defined as ingestion of alcohol at least four nights per week during four hours of bedtime. Intake was calculated in grams of alcohol, with "moderate" intake arbitrarily defined as <52 g daily alcohol intake, predominantly at night, and "severe" intake defined as >52 g/day (1 oz whiskey = 29.46 g alcohol).

Statistical Analysis

Analysis of variance was used for comparison between groups. Separate or pooled t-test was used, depending on the results of the Levene test for equality of variance. For paired comparisons, t-test or non-parametric Mann-Whitney U statistics was used.

RESULTS

OSAS Women

The majority of the OSAS women (mean age 47.8 years) were postmenopausal, but one-third (n = 9) were premenopausal. Their common feature was obesity. Mean BMI was 38.35 ± 6.6, range 26.1 to 51.8. (Normative data for women aged 40 to 65 years show 29.85 percent with a BMI >27.3.) With the exception of one subject, all OSAS women had a BMI >27.3 (Fig 2.) Of nine OSAS women presenting COLD as defined, eight were postmenopausal and one premenopausal. All had a history of smoking a minimum of one pack of cigarettes daily for >20 years and presented with morning cough and regular morning sputum production. Their mean FEV/FVC was 74.2 ± 1.8 percent, mean PaCO$_2$ 39.2 ± 1.1 torr and mean PaO$_2$ 65.4 ± 11.1 mm Hg. Only two OSAS women were "regular alcohol intake" subjects, both within the "severe" category.

All patients complained of EDS. In 63.5 percent of the cases, it was a severe problem impairing daily activities. It led to inappropriately falling asleep during activity (at work or at home,) while driving an automobile, talking to others, etc; patients could fall asleep nearly immediately if seated and not stimulated. EDS was classified as "moderate" in 46.5 percent, with sleep occurring only in quiet situations, although patients complained of continuous tiredness. Heavy, loud snoring with gasp was also present in all subjects: 25.5 percent reported morning confusion, 67.5 percent mentioned frequent (at least four days/week) headaches upon awakening in the morning. All subjects reported nightly sweat and disturbed nocturnal sleep with at least four to five awakenings during the night associated with trips to the bathroom. Night
Mean Body Mass Index by Group

![Mean Body Mass Index by Group](image)

BMI = Body Mass Index

Figure 2. Mean (X) ± standard deviation (SD) of body mass index (BMI) for the different groups studied. Note that OSAS women, especially those who are premenopausal, present with significantly higher BMI than OSAS men or control women.

Cephalometric Measurements by Group

![Cephalometric Measurements by Group](image)

PAS = posterior airway space
PNS-P = length of soft palate
MP-H = mandibular plane--hyoid distance

Figure 3. Mean (X) and standard deviation (SD) of cephalometric measurements obtained on the different groups studied. The length of the soft palate, measured from posterior nasal spine (PNS) to lowest point of the palate, is significantly longer in OSAS men than in other groups. The posterior airway space (PAS) is the widest, and mandibular plane--hyoid (MP-H) distance the shortest, in control women, as expected.

terrors, at times accompanied by screaming, were reported in 96 percent of the cases.

Mean TST on polygraphic monitoring was 342 ± 56'; percentage of stage 1 NREM sleep (SI percent) was taken as an index of sleep disruption, with a mean of 44.7 ± 21.3 percent. In opposition, mean stage 3 or 4 NREM sleep was 8.6 ± 8.0 percent; mean REM sleep, 10.2 ± 8.7 percent. All these results indicated a significantly disturbed sleep for the total population. The patient with the least amount of SI NREM sleep still had a reading of 16 percent, compared with a maximum normative value of 8 percent in our laboratory. Mean RDI was 64.1 ± 31.15, range 13 to 125. Lowest oxygen saturation was 68.2 ± 14.8 percent. Mean O₂-90-I was 30.2 ± 29.4, and mean O₂-50-I was 12.8 ± 24.5. A discrepancy undoubtedly existed between the obesity (massive) and most of the other polygraphic variables and the oximetric variables, with an oxygen saturation higher than expected, in view of weight and RDI.

The mean SNA and SNB angles on cephalometric roentgenograms were 80.6 ± 4 and 77.0 ± 4.9 degrees, respectively; mean PNS-P and mean MP-H distances were 43.1 ± 5.6 mm and 25.8 ± 7.2 mm, respectively. Mean PAS was 4.9 ± 2.2 mm (Fig 3).

Pre- vs Postmenopausal OSAS Women

Women with OSAS were subdivided into premenopausal (n = 9) and menopausal (n = 18) (Table 1). The percentage of clinical complaints varied at times between pre- and postmenopausal women. Seventy-five percent of the premenopausal women reported morning headaches vs 60 percent of the postmenopausal women, and 50 vs 21 percent reported night terrors. Conversely, 71 percent of postmenopausal...
women complained of “severe” (vs “moderate”) EDS, while only 56 percent of the premenopausal subjects had “severe” daytime somnolence.

When the objective data obtained on the two groups were statistically compared, the only variable where the two groups differed was RDI (t = 2.165, p = 0.04); premenopausal OSAS women had a higher RDI. None of the other variables even indicated an established trend, but the mean duration of apnea (19.6 ± 3.9 s in the premenopausal group and 24 ± 8.2 s in the postmenopausal group) was not statistically different. Mean total time spent with disordered breathing per hour of sleep was also calculated; the premenopausal group spent 27.2 ± 13.2 min, while the postmenopausal group spent 22.6 ± 13 min per hour of sleep in apnea or hypopnea. There was, once again, no statistically significant difference.

**Comparison of OSAS Women with Control Women**

A group of 16 premenopausal women was recruited from the orthodontic clinic to serve as control subjects for the cephalometric measurements derived from the roentgenograms of OSAS women. Mean BMI was 25.8 ± 3.8, mean RDI 2.1 ± 1.2. However, as ambulatory monitoring was used in these subjects, no sleep stage variables could be compared. Several cephalometric variables differed significantly when the total OSAS group (n = 27) was analyzed. If SNA and SNB angles were not different (probably related to the fact that control subjects were recruited specifically from an orthodontically-treated pool) all other cephalometric variables differed significantly between groups. OSAS women had a longer soft palate (t = 3.612, p≤0.001), longer MP-H distance (t = 6.038, p≤0.0001) and a smaller PAS (t = 6.357, p≤0.0001). To eliminate the possible effect of menopause on the results (all control women were premenopausal,) a second analysis was performed comparing only the premenopausal OSAS women (n = 9) with the control women (n = 16.) Cephalometric variables were significantly different, with a longer soft palate (t = 2.869, p≤0.009), longer MP-H (t = 7.016, p≤0.0001) and smaller PAS (t = 5.181, p≤0.0001.)

**Comparison of COLD/OSAS Women to OSAS Women**

A comparison was made between nine women presenting with both COLD and OSAS and 18 presenting with OSAS alone. At statistical analysis, none of the variables considered (BMI, RDI, oxygen indices or lowest saturations, sleep factors) was significantly different; the only trend concerned the lowest oxygen saturation during sleep. The O2-50-index—a better indicator of frequency of oxygen desaturation during sleep—indicated no trend (t = 1.846, p<0.08.) The only significant variable was age: COLD/OSAS women were older (t = 2.219, p<0.04.) To avoid the issue of pre- vs postmenopause, we compared, as a second step, postmenopausal COLD/OSAS women (n = 8) to postmenopausal OSAS women (n = 8). Once again, none of the variables was significantly different.

**Comparison of OSAS Women with OSAS Men**

The results obtained on the 110 OSAS men are presented in Table 1. Data analyses indicate that the two OSAS groups are closely related as far as age is concerned. The nocturnal sleep disturbance indicated by the amount of stage 1 NREM sleep is important in

### Table 1—Morphometric, Sleep and Respiratory Variables During Sleep (X ± SD)

| Group                | Age (yrs) | BMI  | TST(min) | % S1 | % S3-4 | % REM | RDI   | LOWO2 | O2/N0 | O2/N0 | MP-H  | PAS   | PAL   | SNA   | SNB   |
|----------------------|-----------|------|----------|------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| OSAS                 |           |      |          |      |        |       |       |       |       |       |       |       |       |       |       |
| Women (n = 27)       |           |      |          |      |        |       |       |       |       |       |       |       |       |       |       |
| Pre-menopausal OSAS  | 47.8 ± 12.7 | 39.4 ± 6.6 | 341.8 ± 56 | 44.7 ± 21.4 | 8.6 ± 8 | 10.2 ± 8.7 | 64.1 ± 31.1 | 68.5 ± 15 | 12.9 ± 24.3 | 30.2 ± 29 | 23.8 ± 7 | 4.9 ± 2.2 | 41.3 ± 5.8 | 80.6 ± 4.0 | 77.9 ± 4.9 |
| Post-menopausal OSAS | 34.1 ± 8.8 | 39.3 ± 4.9 | 359.5 ± 62 | 37.1 ± 21.4 | 10.2 ± 10 | 6.3 ± 4.2 | 81.3 ± 37 | 74.2 ± 8.6 | 4.5 ± 5.3 | 33.5 ± 31.1 | 28.4 ± 6.4 | 4.4 ± 2.5 | 42.2 ± 3 | 82.1 ± 4.7 | 78.1 ± 6.0 |
| Control women        |           |      |          |      |        |       |       |       |       |       |       |       |       |       |       |
| OSAS-W               | 54.7 ± 7.9 | 37.9 ± 7.3 | 337.2 ± 54 | 48.7 ± 20.8 | 7.8 ± 6.2 | 13.3 ± 9.8 | 55.5 ± 24 | 64.8 ± 16 | 17.8 ± 30 | 28.2 ± 29 | 23.4 ± 7.3 | 5.3 ± 2.1 | 43.8 ± 7.2 | 79.4 ± 3.1 | 78.2 ± 4.0 |
| OSAS-W with COLD     | 27.1 ± 7.2 | 25.8 ± 3.8 | —        | —    | —      | —     | —     | —     | —     | —     | —     | 13.4 ± 4 | 10.3 ± 2.6 | 36.1 ± 5.3 | 81.4 ± 2.0 | 78.0 ± 2.1 |
| OSAS-W with COLD     | 44.2 ± 12.9 | 37.4 ± 6.1 | 348.5 ± 62 | 42.8 ± 23.3 | 8.6 ± 7.7 | 8.2 ± 7.0 | 68.8 ± 34.0 | 71.8 ± 12 | 7.7 ± 12.8 | 31.5 ± 29 | 26.5 ± 7.0 | 4.4 ± 2.2 | 41.9 ± 5.6 | 80.9 ± 4.0 | 77.6 ± 4.7 |
| Mean                 |           |      |          |      |        |       |       |       |       |       |       |       |       |       |       |       |
| (n = 110) Normative  | 55.0 ± 9.4 | 40.3 ± 7.4 | 328.7 ± 59 | 48.8 ± 16.8 | 8.5 ± 9.1 | 14.7 ± 10.8 | 54.6 ± 23.4 | 60.6 ± 17 | 25.3 ± 40.1 | 27 ± 30.3 | 23.5 ± 8.5 | 6.5 ± 1.7 | 47.5 ± 2.5 | 79.3 ± 4.3 | 75.0 ± 5.5 |
| data                 |           |      |          |      |        |       |       |       |       |       |       |       |       |       |       |       |
| (men + women) from literature | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  | —  |

COLD = chronic obstructive lung disease
Pre-menopausal = Premenopausal
Post-menopausal = Postmenopausal
PALS = length of the soft palate measured cephalometric x-ray (distance from posterior nasal spine to tip of soft palate).
Table 2—Comparison of 27 OSAS Women to 27 Best-matched Men,* Based Upon RDI, Cephalometric Data and Age

<table>
<thead>
<tr>
<th>Variable</th>
<th>OSAS women (X± SD)</th>
<th>OSAS men (X± SD)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>48.5±12.4</td>
<td>48.7±13</td>
<td>NS†</td>
</tr>
<tr>
<td>RDI</td>
<td>63.2±31.1</td>
<td>61.5±28.1</td>
<td>NS†</td>
</tr>
<tr>
<td>PAS (mm)</td>
<td>4.8±2.1</td>
<td>5.0±2.3</td>
<td>NS†</td>
</tr>
<tr>
<td>MP-H (mm)</td>
<td>25.6±7.6</td>
<td>24.7±4.5</td>
<td>NS†</td>
</tr>
<tr>
<td>BMI</td>
<td>37.7±7.4</td>
<td>30.8±4.5</td>
<td>p &lt; 0.0014</td>
</tr>
</tbody>
</table>

*When each OSAS woman was best matched with one OSAS man based upon age, RDI and cephalometric variables, OSAS women are still significantly more obese than men.

†Non-parametric Mann-Whitney U statistics

‡t test

both groups, but sleep may be more disturbed in women. The 27 OSAS women present a greater reduction in nocturnal TST (t = 3.679, p<0.0001) and a lower percentage of REM sleep (t = 2.365, p=0.03). There are no significant differences in cephalometric roentgenogram findings with the exception of the length of the soft palate, which is significantly longer in men (t = 2.092, p<0.04). The primary difference concerns BMI (t = 6.698, p<0.0001); OSAS women are much more obese than their male counterparts.

A second comparison was made. Using the population results for OSAS men and women, we did a computer search for the best possible match between each man and woman considering age, RDI, MP-H and PAS as the matching variables. The matches were all close (Table 2). We then compared the BMI of the two matched populations. There was a very significant difference (p<0.0001, t-test) between the BMI of OSAS men and women, confirming the general comparison based on gender. OSAS women with a mean BMI of 37.7 were massively more obese than matched men (mean BMI 30.8).

Discussion

Our study covers women with clear symptoms of OSAS seen in a sleep clinic. It once again demonstrates that OSAS is less common in women: we calculated that women represent about 12 percent of our clinic OSAS population. The major cause of OSAS in women, independent of age or hormonal status, is massive obesity.23 By the time that women develop clinical symptoms leading them to seek medical help, they are comparatively much more overweight than men. Even the woman who weighed the least was already on the borderline of obesity, while men of slight build can still present with OSAS (minimum BMI in OSAS men equals I9.8 vs 26.1 in OSAS women). This is also well-demonstrated when an age/RDI/cephalometric findings match was performed to pair each OSAS woman with the most suitable OSAS man. When analysis of BMI was performed between the two groups, OSAS women were found to be much heavier than matched control OSAS men (p<0.0001). Anatomic upper airway abnormalities take on a greater importance in OSAS men than in women, with a longer soft palate present in men. However, compared with control women, OSAS women have abnormal cephalometric findings. Even if the SNA and SNB angles are not statistically different between women’s groups, the length of the soft palate differs considerably (43.1±5.6 vs 36.1±5.5 mm in control women). The distance from mandibular plane to hyoid bone is also significantly longer (25.8±7 vs 13.4±4 mm in control women). Is the low placement of the hyoid bone secondary to aging and repetitive apneas? It is difficult to say. It is known from mandibular osteotomy experiments7 that soft tissue placement, particularly of the soft palate and the secondary hyoid bone location can be easily modified. But there is no proof at this time that the increased transpharyngeal pressure associated with obstructive apnea can induce such significant anatomic modifications. The increased length of the soft palate seen in premenopausal women was not statistically different from that of the postmenopausal (older) group, and the increased length in mandibular plane-hyoid bone distance was contrary to what would have been expected with aging. Could it be that OSAS women initially had anatomic upper airway anomalies which led to mild decrease in alertness inducing less activity, increased weight, etc? Once again it is hard to answer at this stage. However, it must be pointed out that premenopausal OSAS women’s longer mandibular plane-hyoid distance is 28.4±6.4 mm, compared with the 23.4±7.3 mm distance noted in postmenopausal OSAS women. However, despite this lower hyoid placement, premenopausal women have fewer complaints of “severe” EDS (56 percent) than the postmenopausal group (71 percent). This would mitigate against upper airway anatomic abnormalities playing the major role in the development of symptoms. It must also be pointed out that the PAS of the OSAS women is not significantly smaller than that in OSAS men of lighter weight, ie, the neck is infiltrated by fat, as is found in men, and presses on the pharyngeal walls. Nonetheless, when BMI is taken into consideration, women are much more obese for a similar PAS measurement. (Cephalometric results are two-dimensional; however, Riley et al19 recently published data comparing cephalometric measurement of PAS and measurement of airflow using a volume computerized tomography scan obtained on the same patients. A correlation (.93) was found between the three-dimensional analysis results and the measurement obtained from the cephalometric x-rays.20) This suggests that either women have less upper airway anatomic abnormality to begin with than OSAS men, or that women require greater body fat infiltration before having a
significant reduction in PAS. As OSAS women seem to have no difference in MP-H distance than OSAS men, as MP-H distance is abnormally longer in both cases compared with control values (data in the literature and from the control women’s group), the hypothesis that women—even postmenopausal women—have a different fat distribution than do men, seems to be a stronger one.

As already mentioned, BMI appeared to be more important than menstrual status in our patient population, but the severity of the syndrome (using RDI as an objective indicator) is different in pre- and postmenopausal women. Despite similar mean BMI, premenopausal women have a significantly higher RDI, but their time spent in disordered breathing per hour of sleep is not statistically different. It is interesting to note that Partinen and Guilleminault, in a survey of 147 male OSAS patients, found that obese OSAS men have a smaller RDI when compared with normo-weight OSAS men (unpublished data). This may indicate that obese men and obese postmenopausal women have a blunting of their arousal response, while obese premenopausal women may react more in the manner of nonobese OSAS men. Hormonal status would be responsible for the “protection” of massively obese premenopausal women, leading to the higher RDI observed. Finally, the association between COLD and OSAS is possible in women as well as in men.16 It does not seem very surprising to find COLD much more prominent in older postmenopausal women who have a longer history of smoking. Although COLD undoubtedly has an impact on lowest oxygen saturation during sleep and O2-50-Index in men,16 it does not have this impact in women, even when only postmenopausal women are compared. It is suggested that the massive obesity that both groups present is much more significant than the lung disease. It is interesting to note that, despite their combined massive obesity and COLD, none of the nine COLD/OSAS women presented with daytime hypercapnia.20

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REFERENCES