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Talyta Cortez Grippe[1], Dario alhares[1]*, Lisiane Seguti Ferreira[1,2] and Andrea Schappo Bonavides

[1]University Hospital of Brasília. SGAN 604, 70910-900, Brasília, DF, Brazil
[2]Hospital de Base de Brasília. SMHS qd 101. 70330-150, Brasília, DF, Brazil

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***Corresponding author:** Dario Palhares, University Hospital of Brasília. SGAN 604, 70910-900, SQS 416 bl i ap. 294. Asa Sul, Brasília, DF, Brazil, Tel: 55-61-32423638; E-mail: dariompm@unb.br

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Review Article

# Weak Correlation between Clinical Parameters and Polysomnography Findings

**Abstract**

**Purpose**: since about only 30% of polysomnography results confirm the indications, it would be useful to identify clinical data predictive of positive results. The objective is to evaluate the correlation between clinical data and polysomnography findings in a cohort of patients.

**Methods**: 237 polysomnographies and the related clinical data from 226 patients were evaluated retrospectively.

**Results:** the clinical suspicion and the polysomnography findings presented a positive correlation of 69%. However, none of the clinical parameters studied – age, body mass index, neck circumference and Epworth index - was a good predictor of examination.

**Conclusion:** Clinical diagnosis of the syndrome is more important than an isolated assessment of any factor.

## Introduction

Sleep disorders comprise a group of conditions with different clinical origins and expressions, including insomnia and respiratory or motor disorders. Their prevalence in the population is variable, but the most common disorder is Obstructive Sleep Apnea Syndrome (OSAS), followed by insomnia and restless legs syndrome [1]. The diagnosis can be made based on clinical and/or laboratory parameters. Polysomnography (PSG) is the most accurate of the tests available for sleep assessment [1].

PSG records multiple physiological parameters of sleep and aims to access cardiorespiratory and neurologic variables, which allow the quantity and quality of sleep to be assessed as well as the identification of several cardiac, respiratory, and motor events and their repercussions [1,2].

The main complaints of patients who undergo this examination are the usual symptoms of OSAS, including snoring [3] and excessive daytime sleepiness [4]. However, the low frequency of OSAS diagnosis by PSG (31%) is not consistent with the high frequency (71%) of daytime sleepiness reported by patients for whom PSG is recommended.

This discrepancy raises the question of whether data from a medical history and physical examination can predict PSG outcomes and improve indications for PSG examination. Thus, the objective of the present study was to retrospectively compare the request of the sleep exam and the diagnosis of the sleep apnea and other sleep disorders and also to test the correlations between clinical parameters such as body mass index (BMI) [2,5,6], neck circumference [7-9], age [10] and the presence or severity of OSAS.

## Methods

This clinical descriptive retrospective study assessed 237 PSG examinations on a seven-month period. The following factors were evaluated: sex, age, weight, height, BMI, neck circumference, Epworth Questionnaire score (which measures daytime sleepiness) [4,11] and quality of sleep on the night of the PSG examination compared to sleep at home.

The examinations were performed by trained PSG technicians and were analyzed by senior sleep medicine specialists in accordance with the rules of the 2nd International Classification of Sleep Disorders [12]. The PSGs were separated into two categories: those with diagnostic and non-diagnostic intentions as expressed by the physician requesting the examination. The PSGs were considered to have a diagnostic intention when the main indication was sleep-related respiratory diseases, respiratory diseases, narcolepsy, sleep disorders related to seizures, restless legs syndrome, sleep-related periodic limb movements, insomnia, circadian rhythm disorders, or a pre-operative examination prior to bariatric surgery. The PSGs were considered non-diagnostic when they were used to evaluate continuous positive airway pressure (CPAP) or the efficacy of intra-oral appliances.

Among the diagnostic PSGs, the indications were considered to be in agreement with the polysomnographic diagnosis when the clinical suspicion reported in the requirement was confirmed by the PSG exam, or if the test reflected consequences related to the pathophysiological mechanism of the reported symptom. They were also considered concordant if there were indications of snoring, obesity, or hypertension and a diagnosis of OSAS.

The PSG outcomes were considered to be discordant with the clinical suspicion in the following situations: (a) non-specific and/or too broad indications, such as "unspecified sleep disorder" or "unspecified respiratory disorder," since these statements are merely common terms used to obtain health insurance; (b) exams with normal outcomes or unspecific findings, such as changes in sleep architecture; (c) results independent of, and unrelated to, the

indication expressed in the requirement; or (d) OSAS as an indication and "snoring" as the sole finding, given that primary snoring is only characterized after the exclusion of sleep disordered breathing by PSG [13].

Patients were classified as with OSAS when the apnea-hypopnea index (AHI) was > 5. They were classified as suffering from mild OSAS (AHI 5-15), moderate OSAS (AHI 15-30), or severe OSAS (AHI>30) based on the American Academy of Sleep Medicine criteria. The clinical parameters, including sex, age, BMI, neck circumference, and Epworth score, were compared with the AIH values (Table 1).

Statistical analyses were performed using the Chi-square test and kappa statistic with Prism® 5 software; outcomes were considered significant if the p value was <0.05.

## Results

The mean age of the patients was 52 years (range, 20–88 years). They were stratified by age into the following groups (n, %): 20–40 years (54–23%), 41–60 years (99–43%), and >60 years (78–34%). PSGs were performed for 134 men (58%) and 97 women (42%). The mean BMI was 31.12 (range, 15.57–54.96). Patient perceptions of the quality of sleep during the test compared to at home was worse in 118 (52%), the same in 60 (26%), and improved in 51 (22%).

Regarding the diagnostic polysomnography. Table 2 shows the clinical data of patients who underwent a diagnostic PSG. More than 50 different indications for the exam were identified. These are listed in Table 3. The main results of the 144 diagnostic PSGs are shown in Table 4.

The similarity between the indication and the diagnostic PSG results was 69% (n = 109). Among the 49 discordant results, 15 (31%) were due to clinical suspicion of OSAS with only snoring founded in PSG, 15 (31%) due to nonspecific results in PSG, 10 (20%) due to lack of relation between indication and PSG outcome and 9 (18 %) due to unspecific indication in the request. Four PSGs were performed using an expanded EEG montage, three based on a suspicion of nocturnal frontal lobe epilepsy with concordant results.

The most prevalent diagnosis was OSAS. The clinical data as BMI, sex, age, the score in the Epworth sleep scale, neck and waist circumference was compared to the AHI index. According to the correlation index of Spearman, the age (p<0,0001), neck (p=0.0002) and waist circumference (p=0.0073) were significantly correlated with the AIH index, as shown in Figure 1. None of the clinical parameters was suitable for predicting AIH >15, which was independent of all factors or combinations of factors tested. Factors including age >55 years, female sex and age >55 years, and male sex with a BMI >35 kg/m² showed a trend towards statistical significance. The K index, however, only showed a weak correlation with these factors, indicating that it was not possible to predict the outcome of the PSG AIH measure based on these factors.

There was also no statistical correlation between excessive daytime sleepiness and OSAS, even when different cut-offs of the Epworth score (10, 11, and 12) were used. The cut-off that was most closely related to the AIH value was an Epworth score >12, but only in males, and this was not statistically significant (p = 0.1072).

Among the eight patients diagnosed with cardiac arrhythmia, seven had a clinical indication of OSA and one of ischemic heart

**Table 1:** Comparison of clinical parameters and the result of Apnea-hypopnea Index (AHI).

| Clinical parameters | AHI < 15 | AHI < 15 | P | K |
|---|---|---|---|---|
| Gender Female/Male | 51/48 | 21/35 | 0,09 | 0,12 |
| Age <55/>55 years | 64/35 | 25/31 | 0,01* | 0,19 |
| Age (F) <55/>55 years | 30/21 | Jun-15 | 0,03* | 0,41 |
| Age (M) <55/>55 years | 34/14 | 19/16 | 0,16 | 0,30 |
| BMI <35/>35 Kg/m² | 73/23 | 43/13 | 1 | 0 |
| BMI (F) <35/>35 Kg/m² | 19/31 | 12-Sep | 0,19 | -0,15 |
| BMI (M) <35/>35 Kg/m² | 42/5 | 25-Oct | 0,04* | 0,19 |
| Neck circumference >37 or 43/<37 or 43 cm | 35/64 | 26/27 | 0,11 | 0,13 |
| Neck circumference (F) >37/<37 cm | 21/29 | 10-Sep | 0,58 | 0,09 |
| Neck circumference (M) >43/<43 cm | 16/18 | 14/35 | 0,10 | -0,17 |
| Epworth <12/>12 scale score | 64/30 | 32/21 | 0,37 | 0,08 |
| Epworth M) <12/>12 scale score | 34/14 | 18/17 | 0,10 | 0,20 |
| Epworth (F)<12/>12 scale score | 30/18 | 14-Jun | 0,59 | -0,07 |

**Table 2:** Clinical data of patients who underwent PSG with diagnostic purposes.

| Variable | Mean +/-σ |
|---|---|
| Age | 50,8 +/17,6 |
| Gender F/M | 72/83 |
| Body Mass Index (kg.m$^{-2}$) | 30,74 +/- 5,90 |
| Neck circumference (cm) | 39,5+/- 4,11 |
| Epworth Sleepiness scale score | 9,45+/- 5,09 |
| Apnea-hypopnea Index | 14,65+/- 18,26 |

**Table 3:** Clinical indications for the PSG.

| Indications | Total - (%) |
|---|---|
| Sleep Apnea | 84 (35,4%) |
| CPAP/BIPAP tritation | 74 (31,2%) |
| Snoring | 58 (25,5%) |
| High Blood Pressure | 21 (8,9%) |
| Bariatric surgery pre-operatory | 15 (6,3%) |
| Obesity | 13 (5,5%) |
| Others | 13 (5,5%) |

**Table 4:** Results of diagnostic polysomnography.

| Polysomnographic reports | Total – (%) |
|---|---|
| Snoring | 111 (77%) |
| Severe OSAS | 18 (12,5%) |
| Moderate OSAS | 32 (22%) |
| Mild OSAS | 30(21%) |
| Cardiac arrhythmia | 8 (6%) |
| Periodic movements of lower limbs | 3 (2%) |
| Central Apnea | 3 (2%) |
| Cheyne Stokes breathing pattern | 2 (1%) |
| Epileptiform discharges | 3 (2%) |

The sum exceeds 100% because more than one diagnosis can be present in the same patient. OSAS: Obstructive Sleep Apnea Syndrome.

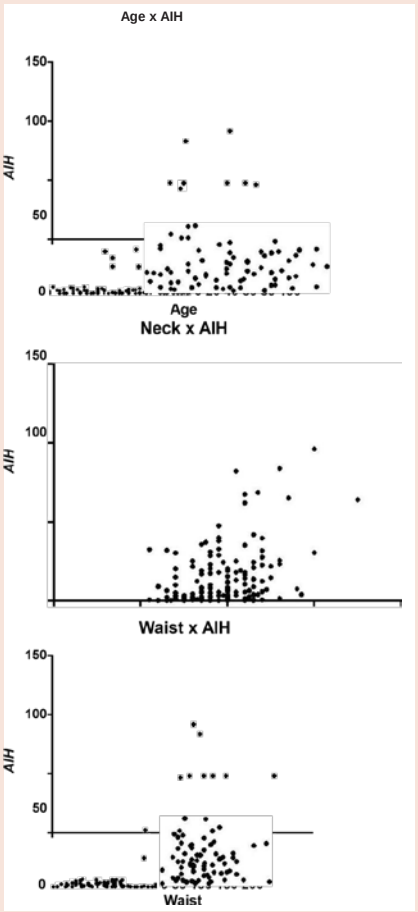


**Figure 1:** Correlation between clinical data and AIH.

disease. Among the three patients with periodic movements of the lower limbs, no clinical indications had pointed this suspicion, one patient was indicated by suspected of OSA and the other two by snoring. Regarding the three cases of central apnea, findings of two were in agreement with the clinical indication, and in the other case the indication was snoring. Among the two cases with a Cheyne–Stokes diagnosis, one patient had a concordant outcome (indicated by previous episodes of stroke), and the second patient had a clinical indication of snoring.

Of the 74 patients who underwent non-diagnostic PSG for titration of positive pressure, 67 (90%) achieved the necessary pressure for CPAP titration and 3 (4%) for BIPAP titration, and 4 (5%) did not adapt to intermittent mandatory ventilation.

When the quality of sleep of the group that used nocturnal CPAP was compared with that of the group without CPAP, significant differences were observed. In the first group, sleep quality improved (better) in 25 (37%), remained unchanged (equal) in 14 (21%), and worsened (worse) in 29 (43%) patients. Among those without CPAP, sleep quality improved in 26 (16%), remained unchanged in 46 (29%), and worsened in 89 (55%) ($p = 0.0028$). Statistically significant differences were observed when the two groups were compared using only the variables "worse" and "equal" ($p = 0.0056$) or "better" and "worse ($p = 0.0023$); there was a higher prevalence of "equal" and "better" sleep in the CPAP group.

## Discussion

Based on current knowledge of sleep physiology and the fact that sleep alters virtually all organ systems, PSG is a useful tool not only for diagnosis but also for monitoring sleep breathing and sleep-related disorders [1].

This study found that some clinical parameters were correlated with PSG outcomes. The set of signs and symptoms explored in the medical consultation were, in most cases, in agreement with the PSG findings and consistent with the diagnosis. The main focus of the study was OSAS, given its high prevalence [14].

Several studies have shown that the prevalence of OSAS increases during middle age, and some have noted a peak in the sixth decade that plateaus thereafter; others have reported peak prevalence at age 55 [10]. The latter finding was similar to that obtained in the present study. The age was significantly correlated with the AIH index. However, age alone was not a predictive factor for OSAS.

The study prevalence of OSAS, 59.35%, was higher than the observed rate of 32.8% reported by Mussman [7] from an analysis of the general population. However, it is in accordance with the >60.0% rate obtained by Mussman et al. [7], and Daltro et al. [10], from evaluations of patients referred with specific diseases.

The patient profile revealed a higher risk of OSAS in obese males [5], but although men had a 1.5-fold greater chance of presenting with a moderate-to-severe AHI than women, this finding was not consistent statistically; a similar finding was reported by Knorst et al. [5], Compared to other studies, in the present study, the large number of women (42%) included is remarkable, which reported a lower prevalence [5,6,8,10]. Thus, the reported tendency towards an OSAS sub-diagnosis in women based on incipient clinical findings [7], might be reduced in our sample.

Regarding BMI, many studies have considered this to be the most important variable for predicting OSAS [5,7,8], our data, however, did not confirm this, and indeed found that even non-obese men under age 50 years can suffer from OSAS. This finding corroborates the approach recommended by the Brazilian Ministry of Health, which does not include a preoperative PSG examination for bariatric surgery and stresses that the clinical data are superior to laboratory findings.

In accordance with Reimão et al. [15], our study found a positive relationship between OSAS, stroke, and ischemic heart disease, which raises the question of whether PSG is a useful test for monitoring patients with multiple risk factors for these conditions. In accordance with findings from other authors, no relationship between excessive daytime sleepiness and OSAS severity [16,17], was detected. In fact, OSAS appears to worsen daytime sleepiness, but does not appear to be the cause of it.

In the present study, waist and neck circumferences were correlated with the AIH index, but both of the circumferences were not useful for predicting the occurrence of OSAS, which supports findings from other series [8,18], this parameter could be more reliable if assessed by magnetic resonance imaging. Other studies have

described the limitations of this parameter since OSAS is associated with alterations caused by systemic metabolic syndrome rather than simply isolated neck circumference [6].

The significance of the Epworth score to predict the diagnosis, as calculated by kappa index, this index is not relevant. Therefore, it can be inferred that the sleep apnea is one of the factors which determinate the daytime sleepiness, but not the only one. As the necessity of sleeping for each individual is different, the tendency to the sleepiness can also be different considering other factors such as age, activities during the day and individual characteristics.

Finally, there was an agreement between the clinical indication and PSG diagnosis in most cases, reflecting a good index of disease suspicion and good criteria for requesting a PSG examination, which is critical for rationalization of resources. Even so, the existence of simple anthropometric parameters that can predict a positive PSG diagnosis of OSAS would reduce costs and promote faster and more accurate diagnosis. Although rates of AIH were directly correlated with parameters such as age, waist and neck circumferences, when testing the clinical significance of this correlation, it was not enough to predict the OSAS diagnosis (AIH > 15). Careful interpretation of positive correlation is needed to avoid the wrong substitution of PSG exam for other parameters, as it will not be able to establish the Sleep Apnea diagnosis as shown by our results. Having said that, the indication of PSG is ratified to be essential for the investigation of sleep disorders.

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## Legends

P = probability obtained with the chi-square test

* = statistically significant difference

F = female

M = male

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