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## Incidence of Insomnia in OSA patients and its correlations with parameters of polysomnography

<sup>1</sup> Vlachou A., <sup>2</sup> Lambrou K., <sup>3</sup> Katsaounou P., <sup>4</sup> Dikaïos D., <sup>5</sup> Damianaki A., <sup>6</sup> Vagiakis E.<sup>1,2,6</sup> Sleep Lab, First ICU Clinic Evangelismos Hospital, 10676 Athens, Greece.<sup>3</sup> First ICU Clinic, National and Kapodistrian University of Athens, 10561 Athens, Greece.<sup>4</sup> National and Kapodistrian University of Athens, Vas Sofias 72, 11528 Athens, Greece.<sup>5</sup> Pulmonary Department "Saint George" General Hospital of Chania, 73300 Crete, Greece.

**Abstract: Background/Aims:** Prevalence of insomnia in obstructive sleep apnoea (OSA) patients has been estimated in many studies and has been found to be a frequent symptom (38% in a recent review <sup>1</sup>). Our study aims to estimate the incidence of insomnia in Greek patients presenting to a public hospital sleep clinic, and correlate it with the severity of OSA and parameters of polysomnography (PSG).

**Methods:** 100 patients who visited the sleep unit of the General Hospital 'Evangelismos' completed the Athens Insomnia Scale (AIS) and underwent a polysomnographic study. 56% were men, with mean age 54,7±12,5 years and BMI 31,5±6,2.

**Results:** 70% of patients had insomnia. Insomnia (AIS≥6) and OSA (AHI≥5) were coexistent in 71,4 %. There was no correlation between insomnia and severity of OSA.

A strong positive correlation was found/evident between difficulty in initiating sleep and number of hypopneas (r: 0,20 p:0,049), diminished functioning during the day and leg movements (r:0,21 p:0,050) and between daytime sleepiness and wake after sleep onset (WASO) (r:0,2 p:0,038).

A negative correlation was found between overnight awakenings and sleep efficiency (r: -0,23 p: 0,021). Also, negative correlation was found between early morning awakening and minimum SpO<sub>2</sub> (r=0,27, p=0,021), and between insufficient duration of sleep (r:-0,22 p: 0,021) and minimum SpO<sub>2</sub>.

**Conclusions:** We found a high incidence of insomnia in patients with OSA, which does not correlate with severity of OSA. Contrary to many other studies, insomnia was not more common in women. More studies are required to clarify the significance of the positive correlation between insomnia and number of hypopneas and minimum SpO<sub>2</sub>.

### INTRODUCTION

Insomnia is characterized by difficulty in initiating or maintaining sleep, reduced duration or quality of sleep (despite adequate opportunity, impairment of daily functioning, for at least 3 times a week, for at least 3 months.

The prevalence of insomnia has been found to differ in several studies, depending on the different questionnaires that are used. Nevertheless, it is a common condition affecting 6-48% of the general population [1-4].

In a study that was conducted in a Greek population (Pappariopoulos et al.), the prevalence of insomnia was found to be 25,3% [5].

Insomnia has been correlated positively with age and negatively with education and socioeconomic status.[6]. Additionally, insomnia has been found to be more common in women than in men. [7-9].

Our study aims to investigate the incidence of insomnia according to the Athens Insomnia Scale, in patients with sleep apnea hypopnea syndrome and correlate it with parameters of polysomnography.

### METHODS

#### *Study design:*

We examined 100 patients who visited the Sleep Unit Of General Hospital 'Evangelismos'. They had been referred

for polysomnography after review by a pneumologist and completing the Epworth Sleepiness Scale(ESS).

The Epworth Sleepiness Scale is a simple questionnaire that assesses daytime sleepiness.

The questions are related to the likelihood of falling asleep in 8 different situations during the day, each rated 0-4. The total score is 0-24 with clinically 'normal' range being 2-10[10].

The AIS is a self-assessment psychometric instrument designed for quantifying sleep difficulty based on the ICD-10 criteria. It consists of eight items: the first five pertain to sleep induction, awakenings during the night, final awakening, total sleep duration, and sleep quality; while the last three refer to well-being, functioning capacity, and sleepiness during the day. The duration of these symptoms has to be at least 3 times a week for at least 1 month [11]. Each answer is graded 0-3 (0 means: 'there is no problem' and 3 means 'very serious problem'). The sum score ranges from 0-24. The best cut-off for diagnosis of insomnia based on ICD-10 was found to be 6. Using this threshold, the scale has a sensitivity of 93% and a specificity of 85%[12]. Patients completed the Athens Insomnia Scale on the day of their PSG [11].

The following parameters were evaluated on PSG: the total sleep time (TST), the sleep latency (SL), the sleep efficiency (SE), the apnea-hypopnea index (AHI), the duration of sleep stages(N1, N2, N3, REM), the wake after sleep onset (WASO), the number of obstructive, central and mixed apneas, the number of hypopneas, the total number of

apneas and hypopneas, the legs movements (LM), and the lowest oxygen saturation (Lowest SpO<sub>2</sub>).

**Statistical analysis:**

The statistical program SPSS 22.0 was used for data analysis.

The mean values, Standard Deviation(SD) and the median values with interquartile range were used for the description of the quantitative variables. The absolute number(N)and relevant frequencies(%) were used for the description of qualitative variables.

For proportional comparison we used the Pearson’s  $\chi^2$  test or the Fisher's exact test when necessary. The Student’s t-

test or the Mann-Whitney test was used for the comparison of quantitative variables between two groups.

The coefficient Spearman(r) was used for the correlation of two quantitative variables. The correlation is thought to be low when it is between 0,1 - 0,3, moderate when it is between 0,31 - 0,5 and high when is over 0,5. In order to find independent variables which are correlated with insomnia, a logistic regression analysis was conducted and the results were presented as odds ratio with 95% confidential intervals. Statistical significance was 0,05.

**RESULTS**

One hundred patients were examined with mean age 54,7 years old(SD=12,5 years), mean BMI: 31,5. 49% were smokers. The demographics are presented in Table 1.

**Table 1**

Mean Value		N	%
Sex	Men	56	56,0
	Women	44	44,0
Age,Mean Value (SD)		54,7 (12,5)	
BMI, mean value (SD)		31,5 (6,2)	
BMI	Normal	6	6,0
	Overweight	38	38,0
	Obese	56	56,0
Smoking	No	51	51,0
	Yes	49	49,0

84%of participants had OSA (27,4% mild OSA, 15,5% moderate and 57,1% severe OSA.). Mean apnoea-hypopnoea index (AHI) was 33±3 events/hour.

90% of the participants reported snoring as the main symptom, 63.6% witnessed apneas, 59% reported dry mouth and 56% fatigue.

37% of participants had arterial hypertension, 31% hyperlipidemia, 18% thyroid gland diseases and 15% clinically significant depression. There was no correlation between comorbidities and the severity of insomnia.

Mean value of Epworth Sleepiness Scale (EPSS) was higher in those with insomnia (Table 2)

**Table 2**

	Insomnia		P Student's t-test
	No	Yes	
	Mean value (SD)	Mean value (SD)	
EPSS	6,9 (3,4)	11,0 (5,3)	<0,001

The results of the AIS are shown in Table 3.

**Table 3**

	N	%	
Sleep induction	No problem	38	38
	Slightly delayd	47	47
	Markedly delayed	15	15
	Very delayed or did not sleep at all	0	0
Awakings during the night	No problem	24	24
	Minor problem	48	48
	Considerable problem	25	25
	Serious problem or did not sleep at all	3	3
Final awaking earlier than desired	Not earlier	41	41
	A little earlier	39	39
	Markedly earlier	16	16
	Much earlier or did not sleep at all	4	4
Total sleep duration	Sufficient	33	33
	Slightly insufficient	43	43
	Markedly insufficient	23	23
	Very insufficient or did not sleep at all	1	1
Overall quality of sleep	Satisfactory	26	26
	Slightly unsatisfactory	47	47
	Markedly unsatisfactory	24	24
	Very unsatisfactory or did not sleep at all	3	3
Sense of well-being during the day	Normal	20	20
	Slightly decreased	46	46
	Markedly decreased	23	23

<b>Functioning (physical and mental) during the day</b>	Very decreased	11	11
	Normal	33	33
	Slightly decreased	51	51
	Markedly decreased	16	16
	Very decreased	0	0
<b>Sleepiness during the day</b>	None	16	16
	Mild	50	50
	Considerable	27	27
	Intense	7	7

Multivariate logistic analysis was performed to identify the correlation between morning headaches, tiredness during the day and insomnia (Table 4).

**Table 4**

		OR (95% ΔE)*	P
Fatigue	No	1,00**	
	Yes	6 (2,31-15,57)	<0,001
Morning headache	No	1,00**	
	Yes	11,42(1,45-89,78)	0,021
N3		1,18 (1,01-1,47)	0,050

Student's t-test \*\*Pearson  $\chi$

Additionally, there was not a statistically significant correlation between sex, age, BMI, smoking status and insomnia (Table 5)

**Table 5**

		Insomnia				P Pearson's $\chi^2$ test
		No		Yes		
		N	%	N	%	
Sex	Men	20	35,7	36	64,3	0,159
	Women	10	22,7	34	77,3	
Age, mean value (SD)		57,2 (12,8)		53,6 (12,3)		0,184*
BMI, mean value (SD)		30,7 (4,9)		31,8 (6,7)		0,400*
Obesity	No	10	22,7	34	77,3	0,159
	Yes	20	35,7	36	64,3	
Smoking	No	11	21,6	40	78,4	0,061
	Yes	19	38,8	30	61,2	

70% of participants had insomnia, based on the Athens Insomnia Scale (Figure I)



**Figure I**

From the correlation between insomnia and polysomnography's parameters, there was found that 71,4% of patients with OSA (AHI:  $\geq 5$ ) had insomnia.

73.9% patients with mild OSA had insomnia, 76.9% with moderate OSA had insomnia and 68.8 % with severe OSA had insomnia (Figure II).

There was no correlation between severity of OSA and insomnia.

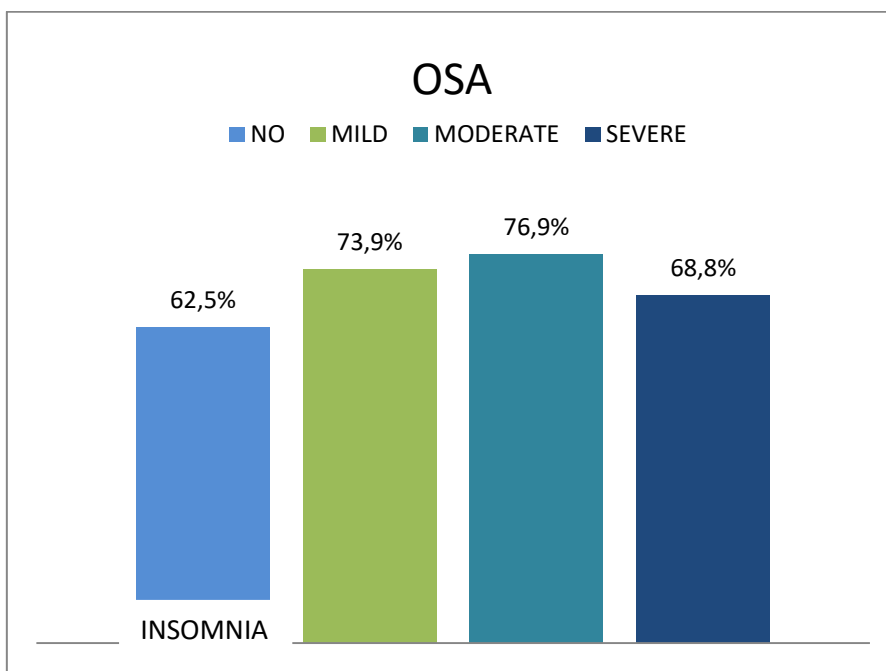


Figure II

The baseline polysomnographic characteristics in OSA patients with insomnia are summarized in Table 7.

Table 6

	Insomnia in patients with OSA				P-value Mann-Whitney test
	No		Yes		
	Meanvalue (SD)	Median(Interq.range)	Meanvalue (SD)	Median(Interq.range)	
<b>Total sleep time</b>	259.4 (95.7)	253 (192.5 – 338.8)	249.1 (98.1)	232 (173 - 319)	0.703
<b>Sleep latency</b>	27.1 (30.5)	16 (3.2 - 38)	26.4 (28.9)	17 (4 – 37.5)	0.949
<b>Sleep efficiency</b>	88.1 (10.8)	91.3 (82.7 – 96.3)	85.1 (13.1)	87.5 (77.1 - 96.8)	0.417
<b>AHI</b>	43.7 (30.2)	38 (14.2 - 75.5)	37 (26.9)	32 (13 - 56)	0.355
<b>N1 (min.)</b>	24.6 (54.2)	7 (4 - 21.3)	16.3 (25.4)	7 (3.5 - 20.5)	0.656
<b>N2 (min.)</b>	193.2 (71.1)	184 (147 - 234.8)	185.3 (77.2)	181.5 (130.5 - 235.1)	0.685
<b>N3 (min.)</b>	4.9 (16.2)	0 (0 - 0)	11.7 (19)	0 (0 - 21)	<b>0.017</b>
<b>REM (min.)</b>	38.2 (35.2)	23.7 (11.9 - 64.3)	36.7 (37.2)	30 (6 - 56)	0.665
<b>Wake after sleep onset (min.)</b>	58.3 (58.3)	45.5 (15.5 - 98.5)	108.3 (324.2)	58.5 (20 - 102.7)	0.502
<b>Number of obstructive apneas</b>	91.7 (77.1)	70 (26 - 134)	72.1 (81.8)	41 (15 - 105)	0.137
<b>Number of central apneas</b>	10.6 (20)	1 (0 - 10)	8.6 (21.7)	1 (0 - 4)	0.593
<b>Number of mixed apneas</b>	12.4 (25.9)	4 (0.5 - 7)	4.4 (7.7)	1 (0 - 5)	0.098
<b>Number of hypopneas</b>	37.4 (31.9)	29 (10.5 - 63)	49.6 (42.3)	45 (13 - 78)	0.291
<b>Total number of apneas-hypopneas</b>	152.6 (88.2)	163 (72.5- 224.5)	134.2 (91.6)	123 (67- 175)	0.269
<b>Periodic limb movement index</b>	0.3 (1.1)	0 (0 - 0)	0.04 (0.22)	0 (0 - 0)	0.799
<b>Lowest SpO2</b>	82.3 (8)	84.5 (81- 86)	83.8 (4.9)	85 (82 - 87)	0.568

The baseline findings between Athens Insomnia Scale and polysomnography of all patients are summarized in Table 8.

Table 7

		Delayed sleep induction	Awakings during the night	Final awaking earlier than desired	Insufficient total sleep duration	Unsatisfactory total quality of sleep	Decreased sense of well-being during the day	Decreased functioning during the day	Sleepiness during the day
Total sleep time	R	0,12	-0,05	0,06	0,11	0,04	0,08	0,00	0,02
	P	0,238	0,620	0,582	0,296	0,657	0,432	0,992	0,844
Sleep latency	R	0,04	-0,16	-0,05	-0,11	0,03	-0,04	-0,11	-0,16
	P	0,706	0,121	0,608	0,266	0,787	0,679	0,275	0,108
Sleep efficiency	R	-0,12	-0,23	-0,12	0,10	0,03	0,05	0,11	0,13
	P	0,247	<b>0,021</b>	0,242	0,318	0,789	0,638	0,269	0,217
AHI(Apnea-hypopnea index)	R	0,03	0,13	0,13	0,12	0,05	-0,04	-0,01	-0,03
	P	0,804	0,181	0,191	0,252	0,643	0,713	0,932	0,797
N1 (min.)	R	0,19	0,19	0,07	0,13	0,06	-0,07	-0,02	-0,10
	P	0,054	0,064	0,460	0,182	0,576	0,478	0,818	0,299
N2 (min.)	R	0,09	-0,05	0,05	0,06	-0,03	0,03	-0,07	-0,06
	P	0,390	0,599	0,609	0,576	0,802	0,777	0,480	0,539
N3 (min.)	R	0,11	0,10	0,03	0,07	0,20	0,14	0,19	0,18
	P	0,280	0,307	0,772	0,499	<b>0,042</b>	0,164	0,065	0,071
REM (min.)	R	-0,01	-0,09	0,08	0,12	0,03	0,07	-0,02	0,14
	P	0,885	0,370	0,405	0,232	0,790	0,510	0,851	0,157
WASO(min.)	R	0,14	0,09	0,04	-0,04	0,04	-0,06	-0,07	0,21
	P	0,171	0,393	0,684	0,661	0,714	0,564	0,514	<b>0,038</b>
Number of obstructive apneas	R	-0,05	0,06	0,05	0,10	-0,01	-0,02	-0,02	0,02
	P	0,645	0,534	0,607	0,310	0,950	0,860	0,838	0,818
Number of central apneas	R	0,06	0,00	0,15	0,00	-0,01	-0,10	-0,09	-0,11
	P	0,565	0,966	0,140	0,965	0,904	0,307	0,395	0,256
Number of mixed apneas	R	-0,05	-0,03	-0,03	0,01	-0,02	-0,07	-0,05	-0,12
	P	0,621	0,752	0,790	0,930	0,814	0,506	0,650	0,221
Number of hypopneas	R	0,20	0,07	0,19	0,12	0,05	0,02	0,04	-0,06
	P	<b>0,049</b>	0,462	0,054	0,253	0,617	0,817	0,690	0,568
Total number of apneas-hypopneas	R	0,08	0,10	0,12	0,15	0,01	0,04	0,03	-0,01
	P	0,437	0,304	0,222	0,141	0,929	0,696	0,746	0,909
PLMI	R	0,09	0,00	0,00	0,02	-0,10	-0,14	-0,18	0,06
	P	0,414	0,964	0,998	0,843	0,380	0,188	0,107	0,581
Legs movements	R	0,11	0,00	-0,04	-0,02	-0,08	-0,14	0,21	0,00
	P	0,313	0,967	0,712	0,837	0,449	0,209	<b>0,050</b>	0,996
Lowest SpO2	R	-0,04	-0,06	-0,27	-0,22	-0,19	-0,02	-0,08	0,02
	P	0,698	0,590	<b>0,009</b>	<b>0,031</b>	0,072	0,854	0,426	0,842

From the correlation between answers in Athens Insomnia Scale and findings of polysomnography the following were observed:

Positive correlation of delay in sleep induction with the number of hypopneas (r: 0,20 p:0,049)

Negative correlation between awakings during night and sleep efficiency (r: 0,23 p: 0,02).

Negative correlation of final awakings earlier than desired (r:-0,27 p: 0,021) and insufficient total duration of sleep (r:-0,22 p: 0,021) with lowest oxygen saturation (SpO2 min) during sleep. Positive correlation of insufficient sleep and N3 stage duration (r: 0,20 p: 0,042).

Positive correlation of decreased sense of well-being during the day, with leg movements during sleep (r:0,21 p:0,050). Positive correlation of daytime sleepiness with wake after sleep onset (WASO) (r:0,21 p:0,038)

## DISCUSSION

The main finding of this study is that insomnia is very frequent in patients with OSA despite the severity of the OSA syndrome (71,4%).

The co-occurrence of both conditions was first described in 1973 by Guilleminaut who described it as a new clinical syndrome. [13].

Among individuals with a presenting complaint related to sleep apnea (eg, snoring, excessive daytime sleepiness, nocturnal breathing issues), the co-occurrence of insomnia varies between 6% and 84%. [15–19,20,21,22,23,24,25]. By contrast, in those seeking evaluation for insomnia, rates of co-occurring sleep apnea ranged from 7% to 69%. [26,27,28,29-31,32]. This big range could be attributed to different definitions and methods that have been used for insomnia in several studies.

Other reasons are the different populations that were used and the different severity of OSA of patients were examined. In some studies was used  $AHI \geq 5$ , in other  $AHI \geq 10$  or 15. Lichstein et al found that 43% of patients with insomnia had

OSA, as it defined with  $AHI \geq 5$ , but only 29%, when AHI was 15 [33].

Individuals who present to a sleep center differs from general population.

Several studies have shown the prevalence of insomnia to be 10-30% among the general population [34-37]. From a study that was conducted among the Greek general population by Paparrigopoulos et al. the prevalence of insomnia in general population was found to be 25,3% (30,7% women 19,5% men) [5]

Many studies have shown that women present more frequently with atypical symptoms such as fatigue, insomnia, depression, nightmares than typical symptoms of OSA, snoring, excessive daytime sleepiness and witnessed apnoeas [38,39]. The fact that in our study there was not found such a correlation could be attributed to the small number of participants.

In our study we pointed out a statistically significant correlation between insomnia and morning headache, dry mouth and impaired memory. Additionally, mean score in EPSS was correlated to Athens Insomnia Scale.

(Symptoms that were found to have statistically significant correlation with insomnia were leg jerks, morning headache, dry mouth and impaired memory. Also, mean score in EPSS was correlated to Athens Insomnia Scale.)

Several studies have shown that co-occurrence of insomnia and OSA is related to more symptoms during day [40,41].

We did not find a significant correlation between insomnia and severity of OSA, though insomnia was more frequent in mild and moderate OSA. Some studies have shown that insomnia is related to lower AHI[42,43].

(Concerning the architecture of sleep, patients with insomnia had bigger duration of N3 stage. This finding is unexpected. Possibly, it is due to the small number of patients who presented N3 during sleep (32%).)

Chung et al.(2005) did not find statistically significant differences in sleep stages between patients with and without insomnia [44]. In a study in individuals from American army, there was found smaller duration of REM stage in patients with insomnia and OSA [45]. In another study of 2016, it was found that most symptoms of OSA, including insomnia are related to smaller duration of N3 stage.[46]. )

In another study that was published in 2018, in which there was made comparison between clinical parameters and parameters of polysomnography between men and women, there was found higher prevalence of insomnia (34% women, 23% men), longer duration of REM and N3 stage in women[47].

Some possible weakness of the current study must be the small number of participants.

In conclusion this study highlights the correlation between OSA and insomnia in both male and female patients but further-larger studies are needed to confirm a correlation between insomnia and various PSG findings.

The correlation that was found between insomnia and number of hypopneas, between awaking earlier than desired and lowest SpO<sub>2</sub> and between insufficient total sleep duration and lowest SpO<sub>2</sub> have to be investigated in more studies.

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