Correlation Of Daytime Sleepiness with Functional Capacity and Fatigue in Obstructive Sleep Apnea Patients.

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***Abstract*—Introduction: Obstructive Sleep Apnea (OSA) is a significant cause of morbidity and mortality in developing countries like India. It is characterized by repeated episodes of partial (hypopnea) or complete (apnea) upper airway obstruction during sleep, resulting in snoring, sleep interruption, hypoxemia, hypercapnia, intrathoracic pressure fluctuations, and increased sympathetic activity. Excessive Daytime Sleepiness (EDS) is a prominent symptom of OSA and is assessed using the Epworth Sleepiness Scale (ESS). Functional capacity is essential component of activity of daily living and effectively measured by the Six-Minute Walk Test (6MWT), which is easy to administer and better reflects everyday activity. Fatigue is a subjective experience involving both physical and psychological aspects which is measured by using the Fatigue Severity Scale (FSS).**

Methods: This was cross-sectional, observational study, aimed to find the correlation of Daytime sleepiness with functional capacity and fatigue in 50 OSA patients. Participants who met inclusion criteria and gave written consent were evaluated using the ESS, FSS, and 6MWT in the Pulmonary Medicine OPD of a tertiary healthcare hospital.

Results: Data were tested for normality using the Shapiro-Wilk test. As ESS and FSS are Likert scales, Spearman's rho correlation was used. Results showed a moderate negative correlation between ESS and 6MWT percentage predicted value ($r = -0.597$, $p < 0.001$), and a moderate positive correlation between ESS and FSS ($r = 0.492$, $p < 0.001$).

Conclusion: This study concludes that increased daytime sleepiness is associated with reduced functional capacity and greater fatigue in OSA patients.

***Index Terms*—Physiotherapy, Obstructive sleep apnea, Daytime sleepiness, Functional capacity, Fatigue.**

I. INTRODUCTION

Obstructive Sleep Apnea (OSA) is a significant cause of morbidity and mortality in developing countries like India. [1] It involves repeated episodes of partial (hypopnea) or complete (apnea) upper airway obstruction during sleep, leading to snoring, disrupted sleep, hypoxemia, hypercapnia, intrathoracic pressure changes, and increased sympathetic activity. [2] According to Indian Initiative on Obstructive Sleep Apnea (INOSA) Guidelines, public awareness of OSA and its effects in India remains low. [2] Community-based studies estimate the prevalence of OSA syndrome to be 2.4–4.96% in men and 1–2% in women. [2] An apneic episode is a complete airflow cessation for ≥10 seconds, while hypopnea is a 30% airflow reduction for ≥10 seconds, causing a 3% drop in oxygen saturation. [3] The primary aetiology of Obstructive Sleep Apnea is small or unstable upper (pharyngeal) airways, [4] and its risk factors include obesity, central body fat distribution, neck circumference, anatomical abnormalities of the craniofacial region and upper airway-specific syndrome, tonsillar and tongue hypertrophy. [2] Obstructive sleep apnea occurs when throat muscles (soft palate, uvula, tongue) overly relax during sleep, obstructing the airway and restricting airflow, which hampers breathing. This leads to hypoxia, hypoxemia,

and hypercapnia. The brain detects this impaired breathing and briefly arouses the person to reopen the airway. This cycle may repeat 5 to 30 times or more each hour throughout the night. [5] Symptoms include loud snoring, [6] nocturnal choking or gasping, [7] difficulty falling asleep, [6,8] morning headache, [6,9,10] daytime sleepiness, fatigue, and impaired functions. [11] Sleep apnea impairs the ability to reach deep, restful sleep, causing frequent arousals, daytime tiredness and reduced concentration, affecting work and social life. It also increases the risk of cardiovascular and cerebrovascular morbidity and mortality, including pulmonary and systemic hypertension, arrhythmia, stroke, heart failure, and coronary artery disease manifestations like nocturnal angina and myocardial infarction. [12,13,14] Obstructive Sleep Apnea (OSA) negatively affects nocturnal sleep quality and leads to daytime fatigue [34]. Shift workers are especially vulnerable to fatigue-related morbidity and mortality in the workplace [35]. Fatigue is linked to poor job performance, unemployment, and increased healthcare costs [36]. It is a subjective experience involving physiological decline and psychological effects such as low morale, impaired judgment, and mood changes. Persistent fatigue is a hallmark of Systemic Exertion Intolerance Disease (SEID), also known as chronic fatigue syndrome (CFS), and is associated with various acute and chronic conditions. Sympathetic hyperactivity may contribute to CFS pathogenesis in OSA [37]. In a study by Kales et al., 78% of 50 OSA patient's self-reported fatigue. The Fatigue Severity Scale (FSS) is a 9-item tool measuring fatigue perception (Krupp et al., 1989). Each item is rated on a 7-point scale (1 = strongly disagree to 7 = strongly agree), with higher scores indicating more fatigue. A total score of ≥ 36 suggests pathological fatigue. The FSS has shown high internal consistency (α = 0.88) and excellent test-retest reliability (r = 0.84) [38].

II. METHODOLOGY

Study Design: Correlation, cross-sectional, observational study.
Study Setup: Pulmonary Medicine Out Patient Department (OPD) At Tertiary Health Care Hospital.
Study Population: Obstructive Sleep Apnea Patients.
Sample Size: 50
Sampling Type: Convenient Sampling.

Inclusion Creteria

- Diagnosed with Obstructive Sleep Apnea (AHI Score ≥5 events/hours) from pulmonary medicine department.
- Age > 30 years old.
- Both the genders.

Exclusion Creteria

- Dyspnea at rest -grade 4 according to modified medical research council (MMRC) grading.
- Patients on Continuous Positive Airway Pressure (CPAP)
- Those with major respiratory, musculoskeletal or neurological Comorbidity.
- Systolic blood pressure > 180 mmhg [33]
- Resting diastolic blood pressure > 100 mmhg [33]
- Resting heart rate > 120 bpm [33]
- Assistive aids for walking
- Major audio-visual impairment
- Patients unable to understand and follow the verbal commands
- Not willing to participate in the study.

N = 51

III. DATA ANALYSIS

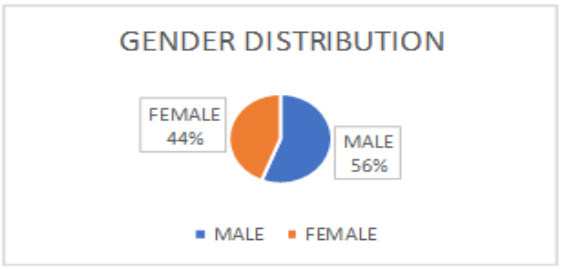
- SPSS software version 26 was used to analyse the data.
- The data was tested for normality using Shapiro Wilk test. The data was not found to be normally distributed. Since, Epworth Sleepiness Scale (ESS) and Fatigue Severity Scale (FSS) is 4 -point and 7- point Likert scale respectively. Hence, Spearman rho's correlation was done.
- For the ease of analysis, data was suggested into:
  1. Demographic data
1. Descriptive statistics- Mean, Standard deviation, Confidence Interval and Standard Error of mean used for Epworth Sleepiness Scale, Functional capacity, Fatigue Severity Scale.
2. The correlation between Epworth Sleepiness Scale (ESS) with Functional Capacity (FC) and Fatigue Severity Scale (FSS) was analysed by Spearman rho's correlation test.

The confidence interval was set as 95% and significance level at 0.05. The data was considered significant if $p < 0.05$.

Graphs And Tables

1. Demographic Data

a) Gender distribution

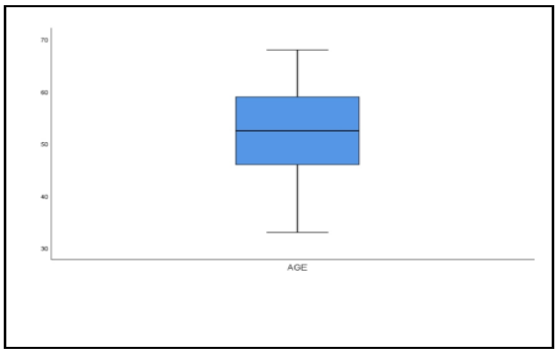


Gender Distribution

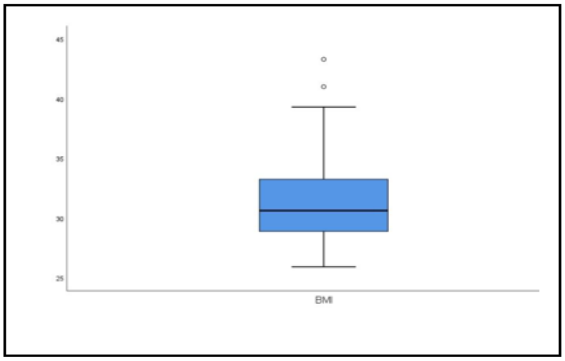
Graph 1: Gender Distribution

Inference: Table No 1a and graph No 1a shows Gender Distribution in this study. Total 50 participants of which 22 (44%) were females and 28 (56%) were males.

b) Age Distribution



c) Body Mass Index (BMI)



Graph No 1c: Body Mass Index

Inference: Table No 1c and graph No 1c shows BMI distribution in kg/m^2. There was total 50 participants with minimum BMI 25.91 kg/m^2 and maximum BMI 43.3 kg/m^2 having a mean of 31.3524 ± 3.92458 kg/m^2.

2.Descriptive Analysis

a) Apnea Hypopnea Index (AHI)

Graph No 2a: Apnea Hypopnea Index

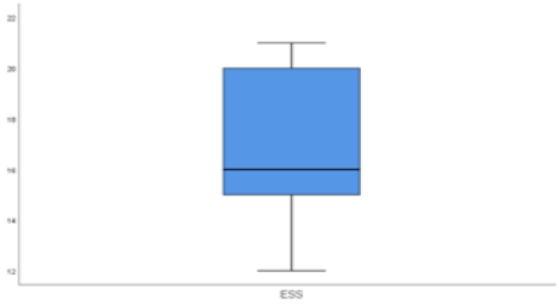
Inference: Table No 2a and graph No 2a shows AHI distribution in events /hour. There was total 50 participants with minimum 5.7 events /hour and maximum 57 events /hour, having a mean of 19.732 ± 11.4765 events /hour.

Percentage Distribution of OSA severity:

Ahi	Frequency	Percentage
Mild OSA	21	42%
Moderate OSA	23	46%
Severe OSA	06	12%
Total	50	100%

Inference: There was total 50 participants out of which 21(42%) were mild OSA, 23(46%) moderate OSA and 6(12%) severe OSA.

b) Epworth Sleepiness Scale (ESS)



Graph No 2b: Epworth Sleepiness Scale

Inference: Table No 2b and graph No 2b shows Epworth Sleepiness Scale (ESS) Score. There was total 50 participants with minimum score of 12 and maximum score of 21, having a mean score of 16.86±2.843.

Percentage Distribution of Daytime Sleepiness severity:

	Frequency	Percentage
Mild Daytime sleepiness	03	06%
Moderate Daytime sleepiness	17	34%
Severe Daytime sleepiness	30	60%

Inference: There was total 50 participants, out of which 3(6%) mild, 17(34%) moderate and 30 (60%) had severe Daytime sleepiness.

IV. RESULTS

Correlation between Epworth Sleepiness Scale and Functional Capacity.

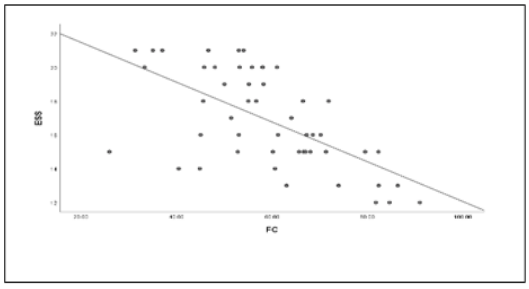
		FC
ESS	Correlation	0.492
	Sig. (2 tailed)	<0.001
	N	50

The data was tested for normality using the Shapiro Wilk Test. The data was not found to be normality distributed. Since the Epworth Sleepiness Scale is a four-pointer Likert scale, Spearman's rho correlation test was done to find the correlation between Epworth Sleepiness Scale and Functional Capacity.

Correlation Spearman's rho

		FC
ESS	Correlation	-0.597
	Sig. (2 tailed)	<0.001
	N	50

Table: Correlation between Epworth Sleepiness Scale and Functional Capacity

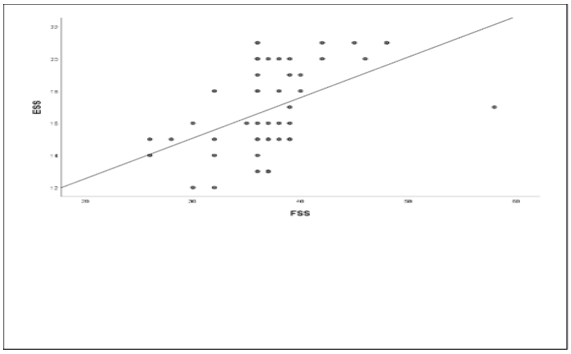


Graph: Correlation between Epworth Sleepiness Scale and Functional Capacity

Inference: Table No 3a and graph No 3a shows significant moderate negative correlation between Epworth Sleepiness Scale and Functional Capacity with r= -0.597 and p value = <0.001, using spearman rho correlation.

a) Correlation between Epworth Sleepiness Scale and Fatigue Severity scale

The data was tested for normality using the Shapiro Wilk Test. The data was not found to be normality distributed Since the Epworth Sleepiness Scale and Fatigue Severity scale is an ordinal scale, Spearman's rho correlation test was done to find the correlation between them.



Graph: Correlation between Epworth Sleepiness Scale and Fatigue Severity scale

Inference: Table No 3b and graph No 3b shows significant moderate positive correlation between Epworth Sleepiness Scale and Fatigue Severity Scale with r= 0.492 and p value = <0.001 using spearman rho correlation.

V. DISCUSSION

The purpose of the study was to investigate the Epworth Sleepiness Scale, Functional Capacity, Fatigue Severity Scale in obstructive sleep apnea patients and to find the correlation between them. To best of our knowledge, this is first study to focus on the correlation of epworth sleepiness scale with functional capacity and fatigue severity scale in obstructive sleep apnea patients.

50 OSA patients, meeting the inclusion criteria participated in the study: 28 males (56%) and 22 females (44%), mean age 52.08 ± 9.08 years. In our study, we found out male is more than female. Historically OSA is predominant male disease. [43] Community based epidemiological studies from several parts of India have estimated that the prevalence of Obstructive sleep apnea syndrome is 2.4-4.96% in men and 1-2 % in women. [2] The higher prevalence of OSA in men is attributed to cultural, anthropometric, and clinical gender differences, including upper airway anatomy, function, and obesity patterns—central in men, peripheral in women (Bonsignore et al., 2019; Fietze et al., 2019).

Body mass index (BMI), an anthropometric measure of body composition, is calculated from height (cm) and weight (kg). In Asians, BMI cut-offs are <18.5 kg/m² (underweight), 18.5–22.9 kg/m² (normal), 23–24.9 kg/m² (overweight), and ≥25 kg/m² (obese) [44]. The mean BMI in our study was 31.35 ± 3.9 kg/m², indicating most patients were obese. Srivastava GN et al. (2020) reported that

obesity increases OSA risk nearly fourfold [45], likely due to craniofacial and upper airway structural factors, greater neck circumference, and fat deposition in the upper airway or abdomen, which increase airway collapsibility during sleep.

OSA increases the risk of cardiovascular, cerebrovascular comorbidities, and mortality [12–14]. In our study, comorbidity prevalence was: hypertension (40%), diabetes mellitus (22%), hypothyroidism (4%), HTN+DM (8%), HTN+hypothyroidism (4%), DM+hypothyroidism (2%), HTN+DM+hypothyroidism (4%), and none (16%). Similarly, Asmath Qureshi et al. (2015) reported hypertension as the most common comorbidity in OSA patients and found a significant positive correlation between number of comorbidities and OSA severity. [46] Phillips CL et al. (2013) described three mechanisms linking OSA to hypertension: (1) recurrent airway collapse causing intermittent hypoxia or hypercapnia and sympathetic activation, leading to vasoconstriction; (2) intrathoracic pressure swings increasing cardiac preload or afterload; and (3) hypoxia-induced oxidative stress, inflammation, and endothelial dysfunction [47]. DM in OSA could be due to sympathetic overactivity, inflammatory cytokines, altered cortisol, and sleep fragmentation. [48] Hypothyroidism in OSA is link with involvement of mucoprotein deposition, reduced neural airway output, obesity, and altered ventilatory control. [49]

Sleepiness, is being in a wake state in which an individual has an increased tendency to fall asleep. Excessive daytime sleepiness is closely related to development of significant cardiovascular disease and comorbidities. [50] Excessive daytime sleepiness (EDS) was assessed using the Epworth Sleepiness Scale, where higher scores indicate greater sleepiness. In our study, 3 (6%) had mild, 17 (34%) moderate, and 30 (60%) severe EDS, with a mean score of 16.86 ± 2.843. Daytime sleepiness increases with OSA severity due to recurrent airway collapse, frequent arousals, and sleep fragmentation.

Functional capacity or exercise capacity, is the ability to perform daily activities. The 6-minute walk test (6MWT) is a practical, inexpensive, and well-tolerated submaximal test reflecting daily activity levels. Many studies indicating that 6 MWT can be useful predictor of mortality in patients with different diseases [Roul et al., 1998; Cahalin et al., 1996; Flaherty et al., 2006]. Distance walked predicts OSA severity and inversely correlates with disease progression. [3] In our study, percentage predicted values were calculated using Ramanathan et al. (2014); mean functional capacity was 59.13 ± 14.93%, lower than Saad HB et al. (2015), likely because their patients were on CPAP, which was excluded in ours. [51] Reduced capacity in OSA is linked to sleep fragmentation, nocturnal hypoxia, daytime sleepiness, and fatigue, leading to decreased activity and overall quality of life. Nocturnal hypoxia during polysomnography has shown significant desaturation during and at the end of 6MWT. [3] Higher BMI worsens capacity by increasing workload, impairing respiratory function, and limiting activity, consistent with previous studies [Plywaczewski et al., 2008; Alameri et al., 2010] [52,53].

Fatigue is described as “an imbalance between individual’s energy potential and performance of daily activities” (Lerdal et al 2005). In this condition, individuals feel exhausted and unable to do activities they normally expect of themselves. Thus, fatigue is differing from sleepiness, as fatigue is defined by a lack of energy rather than a tendency to fall asleep. Subjective fatigue and sleepiness are independent variable. Perception of fatigue was assessed using the Fatigue Severity Scale (FSS), higher score suggests greater fatigue. In our study, fatigue severity mean score was 37.1 ± 5.552 which shows pathological fatigue. Zhou J et al (2015) reported due to nocturnal hypoxemia during sleep contribute to systemic inflammation and result in elevation of pro inflammatory cytokine. [54] According to Mills PJ et al. (2008), fatigue is associated with increase body mass index and elevated level of pro inflammatory cytokine due to sleep disturbance in OSA patients. [55]

Daytime Sleepiness and Functional Capacity

The results demonstrated a significant moderate negative correlation between ESS and FC ($r = -0.597$, $p < 0.001$). This indicates that higher levels of daytime sleepiness are associated with reduced functional capacity in OSA patients. This finding aligns with existing literature that highlights the impact of sleepiness on physical and cognitive performance. Beebe and Gozal. (2002) discussed how daytime sleepiness impair attention, memory, and executive function, which are critical for maintaining daily functional activities. [56] According to Siddiqui F et al. (2015), Excessive daytime sleepiness has shown to reduce functional capacity both at baseline and after

cardiac rehabilitation post coronary artery vascularization with OSA group individuals. [57] The reduction in functional capacity could be attributed to the chronic fragmented sleep and intermittent hypoxia experienced by OSA patients, leading to a state of persistent fatigue and reduced energy levels. This persistent state affects their ability to perform daily activities effectively, thereby reducing their overall functional capacity.

Daytime Sleepiness and Fatigue Severity

Additionally, the study reveals a significant moderate positive correlation between ESS and FSS ($r = 0.492$, $p<0.001$), suggesting that higher daytime sleepiness is associated with greater fatigue severity. This finding is supported by prior research that emphasizes the connection between sleep disturbances and fatigue in OSA patients. A study done by Valko et al. (2008) indicated that subjective fatigue is a common complaint among individuals with sleep disorders, including OSA. observed a moderate yet significant correlation between ESS and FSS. [58] The chronic sleep disruption in OSA leads to insufficient restorative sleep, which manifests as increased fatigue during the day. Fatigue is a multifaceted symptom that not only affects physical performance but also has psychological and social dimensions, contributing to a diminished quality of life. A study done by Jasmin M et al. (2023) showed significant positive correlation ($r=0.398$, $p<0.001$) between ESS and FSS. [59] These relationships are crucial for understanding how daytime sleepiness, as measured by the Epworth Sleepiness Scale (ESS), impacts the daily functioning and perceived fatigue in this patient population.

VI. CONCLUSION

The result of this study supports the alternative hypothesis and provides valuable evidence of the moderate yet significant relationships between daytime sleepiness, functional capacity, and fatigue severity in OSA patients. The negative correlation between ESS and FC ($r = -0.597$, $p<0.001$) highlights the detrimental effect of sleepiness on daily functioning, while the positive correlation between ESS and FSS ($r= 0.492$, $p<0.001$) emphasizes the role of sleepiness in exacerbating fatigue. These findings indicating the importance of targeted interventions aimed at reducing daytime sleepiness to improve overall functional capacity and reduce fatigue in OSA patients.

VII. LIMITATION AND RECOMMENDATION

- The samples were collected from a single institution
- Multicentric study can be done to generalize results.
- Epworth sleepiness scale and fatigue severity scale are self-reported measure; thus, subjective bias may be possible.

Longitudinal study could have been done to see the effect of daytime sleepiness on functional capacity and fatigue in OSA patients.

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