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The Correlation between Fatigue, Obstructive Sleep Apnea Syndrome and Depression in a Sample of Patients at the Hassan II University Hospital Center: Department of Pulmonology : Sleep Unit, Fes-Morocco

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Abstract:
The study aims to monitor the correlational relationship between fatigue, obstructive sleep apnea syndrome (OSAS) and depression in a sample of patients visiting the Hassan II University Hospital Center in Fes. Study tools included the Epworth Sleepi-ness Scale, the Berlin Questionnaire for assessing the risk of sleep apnea, and Beck Depression Inventory. The scales have been translated into Arabic after ensuring their validity and reliability. Participants' ages ranged from 18 to 65+ years, with a male proportion of 34.4% (52) and a female proportion of 65.6% (99). The study results revealed a statistically significant positive correlation ($p < 0.01$) between fatigue and OSAS, with a correlation coefficient of 0.261. Similarly, a statistically sig-nificant positive correlation ($p < 0.01$) was found between fatigue and depression, with a correlation coefficient of 0.561.

Keywords: Fatigue, Sleep, Obstructive Sleep Apnea Syndrome, Depression

1. Introduction

Before delving into the several key aspects related to sleep, its mechanisms, and stages, it is worth emphasizing the idea that methodological advancements significantly influenced the development of research methods, especially with the introduction of electroencephalography (EEG) at the start of the 19th century, known for its scientific rigor and methodological precision. As previously affirmed by [1], we can comprehend much about what happens in the brain and body during sleep, even if we are not fully aware of the actual function of sleep. While sleep can be defined based on observable behavioural changes, the ability to measure the electrical activity patterns of the brain provided an empirical definition of sleep in humans and other mammals.

It is widely agreed that a sleeping individual goes through a cycle of contrasting sleep stages every 90 to 120 minutes during nighttime sleep. Sleep stages oscillate between 5 stages (0 to 4), describing it as a

wakefulness-contradictory sleep cycle [2]. To facilitate the reading of sleep stages, [3] introduced a code for each stage. Stage 0 is Wakefulness (W), followed by Stage 1, Non-Rapid Eye Movement (N1), then Stage 2 (N2), Stage 3 (N3), and finally, Rapid Eye Movement (REM) sleep. However, two of the aforementioned fundamental stages have distinct characteristics. The first one is the slow-wave sleep, which is considered essential for deep rest and energy recovery [4]. In addition to the Rapid Eye Movement sleep, also known as paradoxical sleep (the French call it "paradoxal" because the sleeper's body muscles are almost paralyzed while his brain is very active, which is seen as paradoxical. On the other hand, English speakers refer to it as REM sleep because during rapid eye movement, there are dual and coordinated visual movements).

Thus, if these are some general features of the sleep-wake cycle, disruptions might occur under the influence of various factors, constituting a source of psycho-physical suffering that ultimately impacts sleep quality. Among the most prevalent disorders is obstructive sleep apnea syndrome, defined by [5] as the collapse of the tongue during sleep, leading to frequent awakenings at night and often resulting in daytime sleepiness. Additionally, [6] see it as a complete or partial cessation of airflow through the nose and mouth, lasting at least 10 seconds, and is associated with various symptoms, with fatigue being the most significant.

This latter issue constitutes a fundamental topic of investigation that many researchers agree is a complex phenomenon, intertwined with physiological, psychological, and social factors [7]. In addition, we cannot ignore that fatigue is considered a lack of mental and motor energy resulting from obstructive sleep apnea syndrome (OSAS) [8]. On another note, among the psychological disorders intersecting with obstructive sleep apnea syndrome and causing distress for those affected is depression. This reflects the concept of comorbidity, which is the existence of shared disorders between different clinical conditions [9]. Hence, we find that some symptoms are similar or shared between depression and sleep apnea, particularly physical symptoms like fatigue, pain, and sleep difficulties [10].

2. The Study Issue

Sleep disturbances have become a topic of general interest in psychology, establishing itself in the scientific arena. It has managed not only to participate but also to explain the interconnection between sleep disorders and depression. From this perspective, fatigue constitutes a fundamental symptom for both obstructive sleep apnea syndrome and depression. There is no clear boundary between these two disorders. To justify this stance, it can be summarized in two main points.

The first point considers obstructive sleep apnea syndrome as a mechanical disorder (tongue collapse), leading to breathing interruptions and snoring, resulting in frequent awakenings and a decrease in total sleep time. The second idea is that depression is a psychological disorder that occurs when negative thoughts dominate an individual, such as sadness and difficulty sleeping. In other words, it is a consequence of the absence of physical, mental, and cognitive rest. This duality is mediated by fatigue, as it constitutes a source of both physical lethargy and cognitive deficit. A study by [8] revealed that fatigue affects both genders, especially in individuals with obstructive sleep apnea syndrome, with a prevalence of 46.7% in males and 60.3% in females.

[11] confirmed that those suffering from obstructive sleep apnea syndrome and having high levels of depression experience more fatigue and daytime sleepiness. [12] suggested a partial correlation between fatigue, obstructive sleep apnea syndrome, and depression. The study also recorded a prevalence of obesity and smoking, increasing the likelihood of a sharp rise in mood disorders.

Hence comes our interest in studying these issues, given their scarcity in the Arab and local context, as well as confirming or refuting the existing relationship between the study variables. Therefore, the study problem is defined by the following research questions:

- Is there a statistically significant correlation between fatigue and obstructive sleep apnea syndrome among the study sample individuals?
- Is there a statistically significant correlation between fatigue and depression among the study sample individuals?

3. Hypotheses

- There is a statistically significant correlation between fatigue and obstructive sleep apnea in the study sample.
- There is a statistically significant correlation between fatigue and depression in the study sample.

4. Sample and Variables

The sample includes individuals aged 18 to 65+, with a ratio of 34.4% (52) males and 65.6% (99) females. The examined variables are fatigue, depression, and obstructive sleep apnea syndrome.

5. Statistical Tools

- Simple Regression Analysis.
- Student's t-test.
- Pearson Correlation Coefficient.
-

6. Evaluation and Measurement Tools

It must be noted first that the study sample's medical records were examined, specifically the results of the Polysomnography (PSG). It was found that all patients suffer from obstructive sleep apnea syndrome at moderate and severe rates. We administered the Pichot Fatigue Scale, the Berlin Questionnaire for assessing the risk of sleep apnea (both are self-assessment scales), and the Beck Depression Inventory. It is also worth mentioning that the evaluation and measurement tools have been translated into Arabic, and we have ensured their validity and reliability.

7. Diagnostic Criteria

Diagnosis primarily relies on [13] (DSM-5) to establish the core criteria for the diagnostic process. For depression and its relationship to the study's topic, the criteria must include almost daily presence of symptoms such as physical and libido energy decrease, recurrent fatigue, and difficulty falling asleep. As for the obstructive sleep apnea syndrome, the disorder's severity is assessed based on the number of apnea episodes and respiratory events per hour (Apnea-Hypopnea Index or AHI), which are monitored during the polysomnography.

8. Interpretation/Discussion of the Hypotheses

8.1. The Results of the First Hypothesis

To verify the validity of the first hypothesis, the Pearson correlation coefficient was calculated to determine the significance of the correlation between fatigue and obstructive sleep apnea syndrome among the study sample as follows:

Table 01 illustrates the results of the Pearson correlation coefficient to determine the significance of the correlation between fatigue and obstructive sleep apnea syndrome among the sample individuals.

Table 01. Results of the Pearson correlation coefficient to determine the significance of the correlation between fatigue and obstructive sleep apnea syndrome among the sample individuals.

Scale		The Berlin Questionnaire for Assessing the Risk of Sleep Apnea
Fatigue	Correlation coefficient	0.261**
	Significance Level	0.001
	Sample	151

** Significant at a significance level of 0.01

Table 01 reveals a statistically significant positive correlation at a level of (0.01) between fatigue and sleep apnea, with a correlation coefficient value of (0.261). This value is statistically significant at the (0.01) level. These results indicate that as the level of fatigue increases among the sample individuals, the level of OSAS also increases, and vice versa. To assess the impact of fatigue as an independent variable on OSAS as a dependent variable among the sample individuals, simple linear regression analysis was employed, based on the associated statistical tests.

Table 02 illustrates this:

Table 02. Results of simple linear regression analysis to determine the impact of fatigue on obstructive sleep apnea syndrome among the sample individuals.

Independent Variable	Dependent Variable	Correlation Coefficient (R)	Determination Coefficient (R2)	F-Value	Significance Level (F)	Regression Coefficient			
						Value (β)	T-Value	Significance Level (T)	Significance Level (T)
FATIGUE	OSAS	0.261	0.068	10.897	0.001	Constant	5.83	10.968	0.000
						Effect	0.07	3.301	0.000

Table 02 indicates that the simple regression model to measure the impact of fatigue on obstructive sleep apnea syndrome among the sample individuals is significant, with an F-value of (10.897). This value is statistically significant at the (0.01) level, indicating the effectiveness of the simple regression model in measuring the impact of the independent variable on the dependent variable.

To determine the size of the impact of fatigue on obstructive sleep apnea syndrome, the coefficient of determination (R2) was calculated, with a value of (0.068). This value suggests a small effect size, meaning that fatigue explains only 6.8% of the variance in OSAS. It is also evident that the regression

coefficient (β) is (0.07), representing the effect of fatigue as an independent variable on obstructive sleep apnea syndrome as a dependent variable. This effect is significant, as the value of (T) (3.301) is statistically significant at the (0.01) level. This demonstrates that as fatigue levels increase by one unit, obstructive sleep apnea syndrome increases by (0.07) units, indicating that fatigue had a statistically significant contribution to sleep apnea among the sample individuals. The regression equation can be formulated as follows: (Obstructive Sleep Apnea Syndrome = 5.83 + 0.07 × Fatigue).

Figure 01 illustrates the scatter plot for the linear relationship between fatigue and obstructive sleep apnea syndrome among the sample individuals.

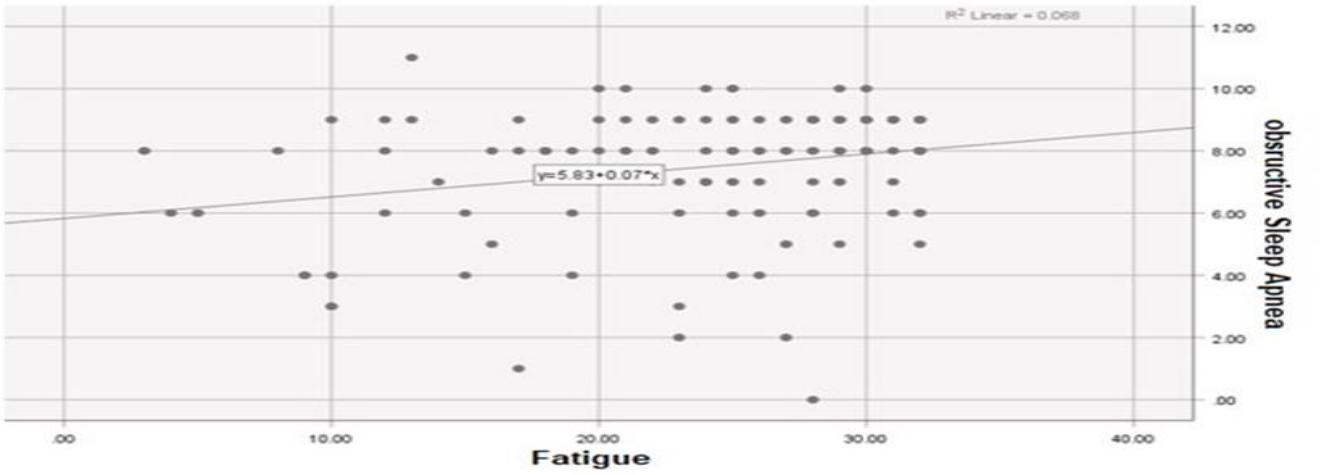

Figure 01. Scatter plot for the linear relationship between fatigue and obstructive sleep apnea syndrome among the sample individuals.

8.2. Interpretation/Discussion of the Results of the First Hypothesis in light of the Correlation between Fatigue and Obstructive Sleep Apnea Syndrome

Based on the results presented earlier, it is evident that the hypothesis has been confirmed as expected, showing a statistically significant positive correlation at a level of (0.01) between fatigue and obstructive sleep apnea syndrome. These findings align with the study by [14], who also confirmed a significant correlation between the mentioned variables. The researchers also noted that fatigue peaks with every two severe apnea episodes during two consecutive nights. This fatigue is attributed to age; as individuals tend to experience a loss of energy and persistent fatigue without a fundamental reason as they age.

[15] indicated that recurrent apnea episodes accompanied by snoring, sequential awakenings, whether total or micro, excessive daytime sleepiness, and fatigue. These are all indicators that define the various aspects of OSAS, and their role in exacerbating the risk of the syndrome. However, Polysomnography revealed differences in heart rate evaluations, and hemoglobin levels carrying iron, responsible for oxygen uptake from the lungs and distribution to the rest of the body. The decrease in oxygen due to respiratory effort control and oxygen saturation, coupled with frequent respiratory interruptions (10 to 20 times per hour), leads patients to prefer daytime sleep over daytime activity.

In contrast to our findings, [16] reported contradictory results. Their study found that approximately 42% of 56 participants suffered from acute fatigue due to obesity. However, they did not find a significant correlation regarding the risk of occurrence or the severity of obstructive sleep apnea syndrome concerning

fatigue and other variables such as gender, age, and Hypertension. The small sample size in this study made it challenging to verify statistical significance. Therefore, it is recommended that the sample size should be larger than the one mentioned.

8.3. Results of the Second Hypothesis

To validate the second hypothesis, the Pearson correlation coefficient was calculated to determine the significance of the correlation between fatigue and depression among the study sample. **Table 03** shows the results of the Pearson correlation coefficient to determine the significance of the correlation between fatigue and depression among the sample individuals:

Table 03. Pearson Correlation Coefficient Results to Determine the Significance of the Relationship between Fatigue and Depression in the Sample.

Scale		Depression
Fatigue	Correlation coefficient	0.561**
	Significance Level	0.000
	Sample	151

** Significant at a significance level of 0.01

Table 03 shows a statistically significant positive correlation (at a level of 0.01) between fatigue and depression, with a correlation coefficient value of 0.561. This indicates that as fatigue levels increase in the sample, so does the level of depression, and vice versa. To assess the impact of fatigue as an independent variable on depression as a dependent variable in the sample, a simple regression analysis was conducted based on the associated statistical tests, as shown in **Table 04**:

Table 04. Simple Regression Analysis Results to Assess the Impact of Fatigue on Depression in the Sample.

Independent Variable	Dependent Variable	Correlation Coefficient (R)	Determination Coefficient (R2)	F-Value	Significance Level (F)	Regression Coefficient			
						Value (β)	T-Value	Significance Level (T)	Significance Level (T)
FATIGUE	DEPRESSION	0.561	0.315	68.417	0.000	Constant	13.54	5.495	0.000
						Effect	0.80	8.271	0.000

Table 04 reveals that the simple regression model to measure the impact of fatigue on depression in the sample is significant, with an F-value of 68.417 (significant at the 0.01 level), indicating the effectiveness of the simple regression model in measuring the impact of the independent variable on the dependent variable. To gauge the magnitude of the effect of fatigue on depression, the coefficient of determination (R2) was calculated and found to be (0.315). This value suggests a large effect size, meaning that fatigue explains approximately (31.5%) of the variance in depression. Additionally, the regression coefficient (β) is (0.80), representing the effect of fatigue as an independent variable on depression as a dependent variable. This effect is statistically significant, as the T-value is (8.271) at a significance level of (0.01). This implies that for every one-unit increase in fatigue, depression increases by (0.80) units. This indicates a statistically significant contribution of fatigue to depression in the sample individuals. The regression

equation can be formulated as follows: (Depression = 13.54 + 0.80 × Fatigue).

Figure 02 illustrates the scatter plot for the linear relationship between fatigue and depression in the sample individuals.

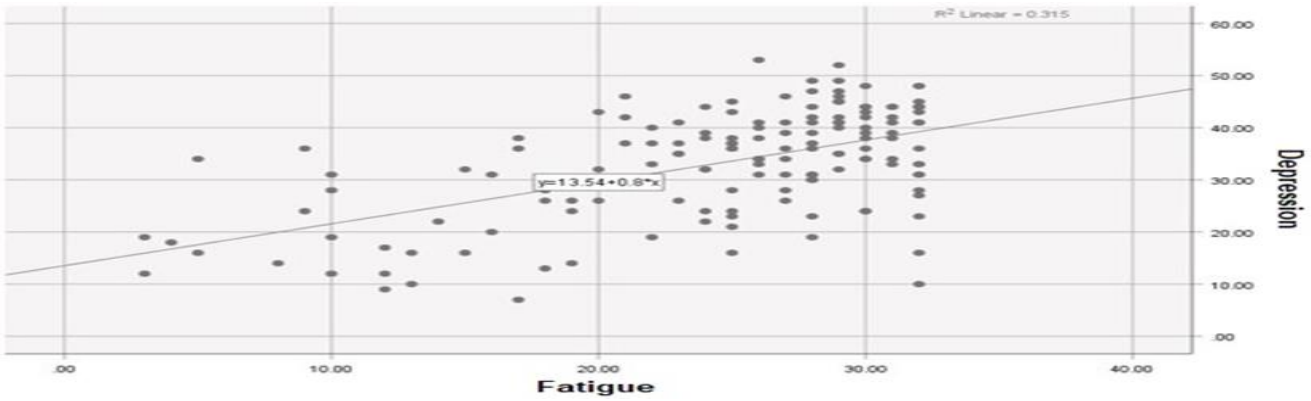

Figure 02. Scatter Plot for the Linear Relationship between Fatigue and Depression in the Sample

8.4. Interpretation/Discussion of the Results of the Second Hypothesis in light of the Correlation Between Fatigue and Depression

The results obtained align with the study by [17], who affirmed a high correlation between fatigue and depression. Since the sample of their study consisted of individuals suffering from obstructive sleep apnea syndrome, and that depression, in their view, is often accompanied by severe fatigue, they suggested focusing on the problem of sleep apnea and its solution as the bridge between fatigue and depression.

The same results were found in a study by [18], which found a statistically significant correlation between fatigue and OSAS. They affirm that depressive symptoms explained 15% of the variation in fatigue. Additionally, self-reported sleep quality contributed to 11% of the variance in fatigue beyond depressive symptoms ($p < 0.001$). The overall model, including all factors, elucidated 48% of the variability in fatigue. Notably, they attributed this to a set of shared variables such as RDI, oximetry, and OSAS severity.

[19] confirmed that sleep apnea is a common disorder associated with a decline in the quality of life. This decline is expected due to the widening circle of fatigue surrounding the patient. As for the symptoms of excessive daytime sleepiness that are often challenging to control, they are limited to the negative impact of the apnea-hypopnea index (AHI) and the level of oxygen saturation (SpO2).

However, when we examine the results of a recent study by [20], they are contradictory to our findings. This study was conducted on the Vietnamese society, using the Epworth Sleepiness Scale for excessive daytime sleepiness, the Pichot Fatigue Scale, and the Hospital Anxiety and Depression Scale for stress and depression. The researchers found no correlation between the Pichot Fatigue Scale and the apnea-hypopnea index, attributing this to the sensitivity of the scale and its lack of adaptation to the Vietnamese society.

According to the study by [21], out of 5464 patients suspected of having obstructive sleep apnea syndrome, they found one in three patients affected by either mild, moderate, or severe apnea, accounting for 70%. Despite the presence of 43% prevalence rate of excessive daytime sleepiness, 39% chronic fatigue, and a

19% prevalence rate of depression, the study did not find statistically significant correlations among these variables. Additionally, the percentage of patients suffering from chronic fatigue did not contribute to the occurrence of frequent interruptions during sleep. This study serves as a call for further research and investigation.

Nevertheless, it is crucial to acknowledge that fatigue due to a heaviness in the appendages, whether upper or lower, is one of the prominent factors in diagnosing the OSAS. Fatigue, in its Aaronic sense (referring to Aaron Beck), affects the mind and is usually associated with a disruption in information processing, handling situations, and recalling automatic thoughts, representing significant symptoms of depression [22].

9. Conclusion

Given the magnitude of the issue presented in this article and its various dimensions, it is essential to emphasize the importance of regular sleep and its decisive role in stabilizing psychological and organic mechanisms in the human body. Fatigue resulting from obstructive sleep apnea disorder provides a foundation for the emergence of depressive disorders. It should also be noted that the need to adjust the psychological perspective on addressing such issues has become paramount, which currently form the basis of health progress and its strategic challenges.

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