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Research Article

Effectiveness of Oropharyngeal Exercise and Side Lying Position on Snoring and Daytime Sleepiness - An Experimental Study

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A B S T R A C T

Background: Breathing disorders connected to sleep are most associated with obstructive sleep apnea (OSA). It is characterized by recurrent upper airway collapses during sleep and can produce obstructive apneas, hypopneas, and arousals related to respiratory effort. Most people with OSA are older men (30-69 years), although it can also afflict women and young children.

Methods: Totally 30 participants were recruited. Eligibility criteria for the study were men and women aged between 30 and to 60yr old; daytime sleepiness, snoring, obesity, neck circumference, smoking, upper airway obstruction, postpartum women, neurologic disease, and uncontrolled blood pressure were excluded. Based on the inclusion criteria, the participants were divided into an experimental group and a control group. In the experimental group, the subjects were asked to perform the oropharyngeal exercise and side-lying position for 15 days.

Result: There is a significant decrease in ESS (Epworth Sleepiness Scale) score, with a Z-value of -3.42 ($p=0.001 <0.05$), indicating that the ESS score is reduced significantly. There is a significant decrease in SSS score, with a Z-value of -3.45 ($p=0.001<0.05$), indicating that the SSS score is reduced significantly due to oropharyngeal exercise and side-lying position.

Conclusion: This study's conclusion shows a statistically significant improvement in snoring and daytime sleepiness and improved quality of life for those who received oropharyngeal exercise along with a side-lying position, as measured by both ESS and SSS scores, with a greater impact observed on ESS scores than SSS scores among OSA subjects.

Keywords: Obstructive Sleep Apnea, Oropharyngeal Exercise, Snoring, Sleep Position

Introduction

A harsh or hoarse sound occurs from the mouth or nose while breathing is partially blocked during sleeping. Obstructive sleep apnea is the most prevalent sleep-related respiratory condition. It is distinguished by recurring upper airway collapse during sleep and can produce obstructive apnea, hypopneas, and arousals associated with respiratory effort. Most individuals with obstructive sleep apnea are older men (60-79 years), although it can also afflict women and young children.[1] Approximately 936 million adults globally, between the agesof 60-79 years are thought to possess average to extreme obstructive sleep apnea, with four hundred and twenty-five million falling into the moderate to severe category within the same age range.[2]

Obesity results in constriction of the upper airway structure owing to the infiltration of adipose tissue and deposition of fat in the cervical region. In addition to the augmented burden on the ventilatory system, it raises the possibility of pharynx collapse, concomitant with a decrease in intrathoracic volume and diaphragmatic excursion.[3]

In addition, the superfluous daytime somnolence arising from disrupted sleep can diminish bodily movement, consequently culminating in weight accumulation.[4] The risk factors linked with obstructive sleep apnea comprise an excessive Body Mass Index (BMI). Other potential risk factors linked to obstructive sleep apnea include craniofacial or upper airway abnormalities, nasal congestion, and smoking. A genetic predisposition towards specific craniofacial structures can also augment the likelihood of developing obstructive sleep apnea, neck size or waist circumference is more strongly correlated with obstructive sleep apnea than general obesity.[5]

If left untreated, obstructive sleep apnea is correlated with potential everlasting health outcomes, for instance, an increased risk of cardiovascular disease, metabolic disorder, cognitive impairment anddepression, and additional prevalent indications comprise excessive daytime drowsiness, fatigue, sleep without rejuvenation, nocturia, morning headache, irritability, and amnesia. Studies indicate that training the upper airway muscles is a positive approach for improving average obstructive sleep apnea and reducing the harmful effects associated with obstructive sleep apnea.[6,7]

Myofunctional therapy or oropharyngeal exercises are techniques that have been proven to increase the muscle tone around the airway, which can help to alleviate symptoms of obstructive sleep apnea. During myofunctional therapy or oropharyngeal exercises, the musculature of the pharyngeal wall, tongue, and soft palate are the primary structures targeted. Those muscles are responsible for essential functions like biting, speech, breathing, and swallowing. Oropharyngeal exercises have been shown to increase the activation of upper airway muscles, resulting in a wider upper airway diameter, reduced airway resistance, and opposing pharyngeal collapse during sleep. The practice of oropharyngeal exercises is effective in improving the genioglossus and pharyngeal musculature, which are essential in preserving upper airway patency at rest.[8] It has the potential to reduce upper airway edema and collapsibility, improve tongue position, and get control of the harmful effects of a long floppy soft palate and uvula during sleep. In addition to improving upper airway patency, oropharyngeal exercise was , found to expand the contractility of facial muscles, which can elevate the mandible and hyoid bone to prevent mouth opening during sleep.[9]

Positional therapy can be defined as the strategic prevention of individuals from assuming suboptimal sleeping positions. An additional treatment option for obstructive sleep apnea and snoring is positional therapy.[10] The impact of the lateral sleeping position on the position of the tongue and airway patency in comparison with the supine position remains unfamiliar. Similarly, alterations in epiglottic occlusion caused by sleep posture have not been thoroughly delineated. Our hypothesis postulated that the enhanced patency of the superior respiratory tract from the supine to the lateral sleeping position would rely on the anatomy responsible for the pharyngeal collapse.[11] The aim of the study is to find the effectiveness of Oropharyngeal exercise and side-lying position on snoring and daytime sleepiness. The objectives are to determine the efficacy of oropharyngeal exercise on snoring as well as daytime sleepiness, to determine the efficacy of side-lying positions on snoring and daytime sleepiness, to compare the effectiveness of oropharyngeal exercise and side-lying positions on snoring and daytime sleepiness

Methods and Materials

An experimental study was conducted using a randomized controlled trial design, with both pre-test and post-test results obtained. The two techniques were compared to assess their effectiveness in reducing snoring and daytime sleepiness. The participants' informed permission was acquired before the group assignment. The time frame for conducting this investigation was March 2024–April 2024 and was ethically approved by the Institutional Human Ethics Committee for Student Research (IHEC-I/2367/23).

A total of 30 candidates have been chosen & divided into two groups, with 15 individuals in each. The subjects selected were referred from the Chettinad Academy of Research and Education, Department of Respiratory Medicine. All 30 participants provided a signed consent form. A simple random sampling technique - a computerized number generator was used to choose them. Their inclusion criteria

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(Gender: Male and female, daytime sleepiness [Epworth Sleepiness sScale], snoring [Snoring Severity Scale], Obesity, and Age: 30- 69) and exclusion criteria (neurologic diseases, heart failure, uncontrolled BP, age less than 30, pregnancy, mouth ulcers, smoking, postpartum women, and upper airway infection) were used to choose the subjects. The subjects have been given information in their native language about the study's methodology, goals, risks, advantages, and results. The subjects were conveniently split into two groups (the oropharyngeal exercise group along with the side-lying position group). The experimental group was given the oropharyngeal exercise and side-lying position intervention, whereas the control group was given the side-lying position intervention. Pretests were conducted using the snoring severity scale and Epworth sleepiness scale for snoring and daytime sleepiness. The total duration of the study is about 2 weeks.

Oropharyngeal Exercise Group

Oropharyngeal exercise group participants were chosen according to their inclusion and exclusion standards in the case of snoring and daytime sleepiness. The oropharyngeal exercise is frequently used to increase the tone of the pharyngeal muscles. It is particularly beneficial for people who need to increase the tone of the muscle of the pharynx, which helps them to decrease the snoring and daytime sleepiness of the people. Each participant underwent 5 exercises i.e., performing lingual alveolar closure by sliding the dorsum of the tongue towards the posterior pharyngeal wall, and repeating this action for a total of 20 times, pressing and elevating the whole tongue against the palate repeatedly (20 times), performing 20 repetitions of pressing the hindmost position of the tongue opposed the lingual surface of the oral cavity on the other hand simultaneously positioning the apex of the tongue in contact with the mandibular incisors, elevate soft palate and uvula on the other hand periodic vocalizing the vowel sound 'A ' for a total twenty repetitions, put your finger in your mouth and apply pressure on the buccinator muscle towards the outside (10 times on each side). Make sure to chew and swallow food on both sides of your mouth while eating. Patient position is relaxed high sitting with hands resting on the side and legs hanging. The therapist is in stride, standing in front of the patient, prescribing exercises, and monitoring them. Side-lying sleeping positions were recommended for the patient along with the oropharyngeal exercise.

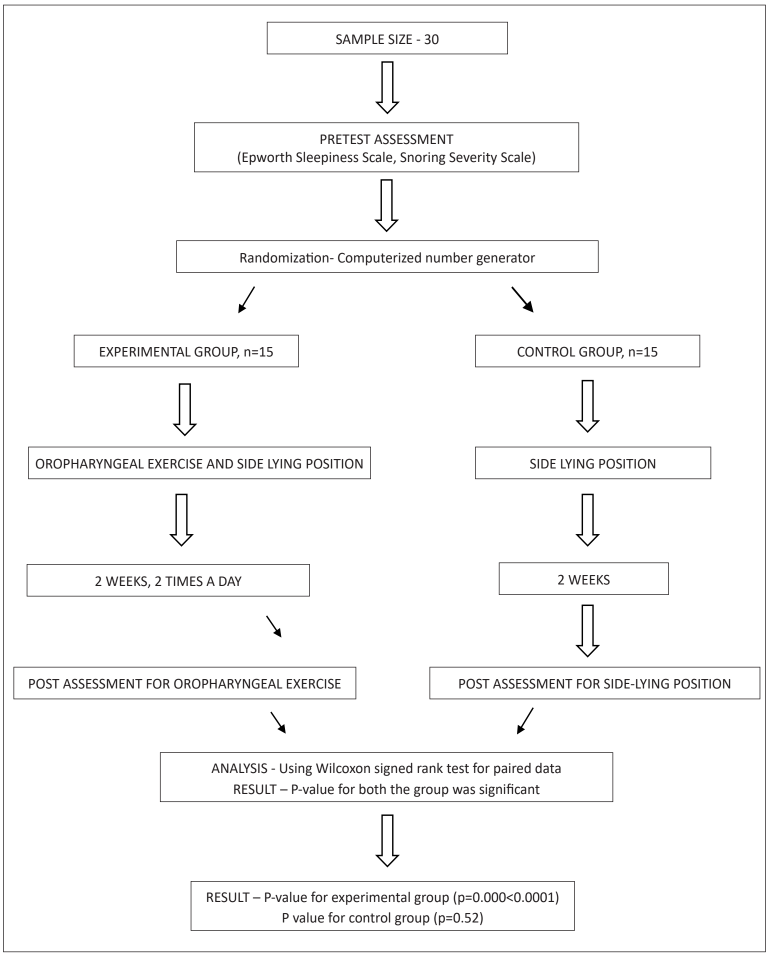

Figure 1.Flow Chart of Data Collection and Analysis

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Results

Statistical Methods Used

1. Descriptive Statistics
2. Wilcoxon Signed Rank Test for Paired Data
3. Mann Whitney Test to compare two Independent Groups

Software Used

1. Excel Data Analysis Tool
2. SPSS v20

Descriptive Statistics

In comparing the descriptive statistics between the experimental group and the control group, several key differences and similarities emerge. Group A, comprised of 15 individuals, exhibits slightly higher mean ages (48.73 years) compared to Group B (48.27 years). The standard deviations of ages are 10.36 and 9.37 for Groups A and B, respectively, indicating similar age variability. Both groups show similar patterns in body mass index (BMI), with Group A having a mean of 33.21 and Group B with 31.06. Notably, Group A demonstrates a higher waist circumference mean (42.67) compared to Group B (40.93), suggesting potentially greater abdominal adiposity in Group A. Additionally, Group A has a higher mean neck circumference (17.33) than Group B (17.47), albeit the difference is minor. In terms of sleep-related parameters, Group A starts with a higher mean Epworth Sleepiness Scale (ESS) score of 15.87 pre-intervention, which decreases to 6.93 post-intervention, while Group B starts with a lower mean ESS score of 13.73 pre-intervention, decreasing to 9.60 post-intervention. Moreover, Group A begins with a higher mean Stanford Sleepiness Scale (SSS) score pre-intervention (7.07) compared to Group B (6.87), which drops to 3.53 post-intervention in Group A and 3.93 in Group B. Gender distribution indicates that both groups have a predominantly female composition, with Group B having a slightly higher proportion (64%) compared to Group A (57%). These findings highlight nuanced differences in demographic and health-related variables between the two groups, potentially influencing interventions or further research considerations.

Descriptive Statistics

Table 1.Descriptive Statistics for Demographic Variables and Outcome Measures – Group A

-	Count	Min	Max	Mean	SD
Age	15	32.00	65.00	48.73	10.36
BMI	15	27.10	39.30	33.21	3.52
Waist Circumference	15	39.00	48.00	42.67	2.61
Hip Circumference	15	41.00	50.00	46.00	3.27
Neck Circumference	15	15.00	19.00	17.33	1.35

Table 2.Descriptive Statistics for Demographic Variables and Outcome Measures – Group B

-	Count	Min	Max	Mean	SD
Age	15	34.00	64.00	48.27	9.37
BMI	15	25.70	35.90	31.06	3.31
Waist Circumference	15	36.00	48.00	40.93	3.51
Hip Circumference	15	42.00	51.00	45.40	3.04
Neck Circumference	15	15.00	19.00	17.47	1.19

Table 3.Gender Distribution

Gender	Group A	Group B
Male	6 (43%)	5 (36%)
Female	8 (57%)	9 (64%)
Total	14 (100%)	14 (100%)

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Inferential Statistics

Intra-Group Analysis (i.e., Within Group Analysis)

Wilcoxon Signed Rank Test: To test whether there is a significant reduction in outcome measures (ESS &/or SSS) from Pre- to Post-test in each experimental group

The Wilcoxon Signed- rankTest was conducted to differentiate the pre & post-test scores for the two outcome measures -ESS & SSS – in participants from the two groups: the experimental group & the control group.

For the Experimental Group (i.e., Group A

ESS Score

There is a significant decrease in ESS outcome deriving out of pre-test (median = 15.00) to the post-test (median = 6.00), with a Z-value of –3.42 ($p = 0.001 < 0.05$), indicating a well-known ESS score is reduced significantly from pre- to post-test due to oropharyngeal exercise and side-lying position (i.e., the experimental group).

SSS Score

There is a significant decrease in the SSS outcome from the pre-test (median = 7.00) to the post-test (median = 4.00), with a Z-value of –3.45 ($p = 0.001 < 0.05$), indicating a well-known SSS score is reduced significantly from pre- to post-test due to oropharyngeal exercise and side-lying position (for the experimental group).

For the control group (i.e., Group B)

ESS Score

There is a significant decrease in ESS outcome deriving from the pre-test (Mmedian = 14.00) to the post-test (median = 9.00), with a Z-value of –3.45 ($p = 0.001 < 0.05$), indicating a well-known ESS score is reduced significantly from pre- to post-test due to the side-lying position of Treatment B.

SSS Score

There is a significant decrease in the SSS outcome from the pre-test (median = 7.00) to the post-test (median = 4.00), with a Z-value of –3.53 ($p = 0.000 < 0.05$), indicating a well-known SSS score is reduced significantly from pre to post-test due to the side-lying position in Treatment B.

The above results indicate that both the experimental Group and the control group remarkable reduce the values of ESS and SSS outcomes from the pre-test to the post-test.

Inter-Group Analysis (i.e., Between-Group Analysis)

Treatment Comparison (Experimental Group Vs Control Group)

A Comparison of Experimental Group with Control Group in Terms of reduction in ESS scores and SSS scores from Pre- to Post-test

To test whether the experimental group is effectively different from the control group in terms of reduction in ESS and SSS scores, we have computed the difference variable for both the outcome measures as follows:

- ESS Diff = ESS Post-Test – ESS Pre-Test
- SSS Diff = SSS Post-Test – SSS Pre-Test

The output of the Mann-Whitney test provides insights into whether there is remarkable changes in the experimental group (Group A) & the control group (Group B) in terms of the reduction in ESS (Epworth Sleepiness Scale) and SSS (Stanford Sleepiness Scale) scores from pre- to post-test.

The Mann-Whitney U test evaluates whether there is a remarkable variance linking the two groups. For the reduction in ESS scores, the Mann-Whitney U value is 3.00, and the corresponding Z-value is -4.595. The p-value associated with this test is extremely low ($p = 0.000 < 0.001$), indicating a remarkable variance linking the two groups in terms of reduction in ESS scores.

Conversely, for the reduction in SSS scores, the Mann-Whitney U value is 68.50, and the Z-value is -1.941. The associated p-value is 0.052, which is marginally higher than the typical significance threshold of 0.05, suggesting a borderline remarkable linkbetween the groups in terms of reduction in SSS scores.

In summary, the Mann-Whitney test results suggest that there is a remarkable variance linking the experimental group (Group A) & the control group (Group B) in terms of the reduction in ESS scores, but the difference in reduction in SSS scores is not as pronounced, although it approaches significance. This implies that the treatment intervention has a more substantial effect on reducing ESS scores compared to SSS scores.

In ESS, the significant Z-value is -4.595 and the p-value associated with the test is extremely low ($p=0.000 < 0.001$), indicating an appropriate variation linking the two groups in terms of reduction in ESS scores.

In the SSS, score, the significant Z-value is -1.941 and the related p-value is 0.052, an implication of a borderline difference between the groups in terms of reduction in ESS score.

In conclusion, the findings are that that the oropharyngeal exercise and side-lying position intervention effectively reduced sleepiness levels, as measured by both ESS and SSS scores, with a greater impact observed on ESS scores compared to SSS scores.

Inferential Statistics

Intra-Group Analysis (i.e., Within Group Analysis)

The Wilcoxon Signed Test was conducted to differentiate the pre & post-test scores for the two outcome measures -ESS & SSS – in participants from the two groups: the Experimental Group & the control group.

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Inter-Group Analysis (i.e., Between-Group Analysis)

Treatment Comparison (Experimental Group vs Control Group)

A Comparison of Experimental Group with Control Group in terms of reduction in ESS scores and SSS scores from Pre- to Post-test

After computing the above-differenced variables, the two groups were compared based on these two variables ESS Diff and SSS Diff using the Mann-Whitney Test, and the corresponding output is presented below:

Table 4.Wilcoxon Singed Rank Test (Paired Sample Test) - Output

Descriptive Statistics							
Groups	**Outcome Measure**	**N**	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**Median**
Group A	ESS_PRE	15	15.87	4.612	9	24	15.00
	SSS_PRE	15	7.07	1.280	5	9	7.00
	ESS_POST	15	6.93	3.011	3	13	6.00
	SSS_POST	15	3.53	1.060	2	5	4.00
Group B	ESS_PRE	15	13.73	4.200	8	23	14.00
	SSS_PRE	15	6.87	1.125	5	9	7.00
	ESS_POST	15	9.60	4.222	5	19	9.00
	SSS_POST	15	3.93	1.100	2	6	4.00

Table 5.Wilcoxon Singed Rank Test (Test Statistic)

Test Statistics			
Groups	**Values**	**ESS_POST - ESS_PRE**	**SSS_POST - SSS_PRE**
Group A	Z	-3.420[b]	-3.453[b]
	P-value	.001	.001
Group B	Z	-3.453[b]	-3.531[b]
	P-value	.001	.000

Table 6.Output of Mann-Whitney Test

Summary Statistics				
-	**Reduction in ESS**		**Reduction in SSS**	
-	**Group A**	**Group B**	**Group A**	**Group B**
Count	15.00	15.00	15.00	15.00
Min	-12.00	-5.00	-5.00	-4.00
Max	-5.00	-3.00	-2.00	-2.00
Mean	-8.93	-4.13	-3.53	-2.93
SD	1.91	0.83	0.99	0.59
Median	-9	-4	-4	-3

Table 7.Mann-Whitney Test (Test Statistic)

Test Statistics		
-	**ESS Diff**	**SSS Diff**
Mann- Whitney U	3.000	68.500
Wilcoxon W	123.000	188.500
Z	-4.595	-1.941
P-value	.000	.052

Discussion

Myofunctional therapy, also known as oropharyngeal exercises, encompasses an assortment of exercises such as tongue, soft palate, facial, and functional exercises. The primary objective of these exercises is to enhance the strength of the muscle that ensures the upper airway remains unobstructed.[12] The genioglossus and pharyngeal musculatures are crucial in OSA and can be enhanced through oropharyngeal exercise. Contemporary scientific evidence endorses the usage of oropharyngeal exercises typically employed in the context of speech production and dysphagia refurbishment for ameliorating OSA. Such exercises may have a variety of potential favors, including, but not limited to, diminishing neck circumference, snoring, subjectively perceived drowsiness, and AHI, in addition to enhancing the standard of living. The genioglossus muscle is the most formidable and dominant upper respiratory tract dilator; nevertheless, its sole muscle activation may prove inadequate in mitigating pharyngeal collapsibility. The current research indicates that oropharyngeal exercises enhance the pharyngeal muscle tone because of regular exercise.[13]

The underlying principle of employing orofacial myofunctional exercises for treating sleep apnea is to enhance respiratory muscle strength, thereby augmenting the muscular tone of the upper airway dilators. The augmentation of muscular tonicity aids in preserving the openness of the pharyngeal airspace.[14]

OMT can serve as a pivotal component in the supervision of obstructive sleep apnea (OSA) owing to its established efficacy on the muscular architecture of the Upper Airways.[15] OMT can be utilized as an independent therapeutic measure for adult and pediatric patients with obstructive sleep apnea, with effectiveness supported by data available in the literature. The latest research indicates the possibility of utilizing Osteopathic Manipulative Treatment (OMT) as a constituent of a comprehensive strategy aimed at enhancing the functioning of the pharyngeal musculature. Contemporary research suggests that consistent oropharyngeal exercises bolster the pharyngeal musculature, leading to heightened muscle tone.[16]

In contemporary times, the implementation of OMT has emerged as an innovative methodology for treating individuals suffering from obstructive sleep apnea (OSA), thereby ushering in a new dimension to the quest for mitigating or eradicating an ailment with grave ramifications for the welfare of humanity.[17] The outcomes of randomized experiments, albeit limited in number, have evinced the effectiveness of OMT for adults encountering average to severe obstructive sleep apnea (OSA)with primary snoring and for juveniles suffering from leftover apnea. Moreover, it yields advantages such as an enhanced standard of living.[18]

The study conducted in a randomized controlled manner is the foremost investigation into the impact of upper airway musculature guidance utilizing a sequence of oropharyngeal exercise amongst individuals detected with average obstructive sleep apnea syndrome.[19] After three months, the seriousness of OSAS, as measured with the AHI & the lowest oxygen saturation resolved by polysomnography, was reduced by 39% due to exercise training. The notable amelioration of OSAS in the individuals who were randomized to musculature guidance transpired in parallel with a decrease in snoring, diurnal somnolence, & sleep quality rating. Although there were no noteworthy modifications in body physique, individuals subjected to oropharyngeal therapy evinced a marked diminution in neck circumference. This outcome postulates that exercises implemented upper airway restructuring. Variations in the apnea-hypopnea index denoted an adverse correlation with modifications in cervical circumference. The current investigation evinces marked amelioration in the condition of snoring along with a notable enhancement in diurnal somnolence.[20] The limitation of this study was that the sample size is small, the study duration was minimal, and no further follow-up was taken, which can include moderate Blood pressure population, the sleeping position can be modified and monitored with new techniques for more outcomes. Further research with modifications such as oropharyngeal electromyography can be conducted to create more evidence-based practice. This study can be further proceeded with both the methods of exercise and sleep position modification for more effectiveness. The young adult population in the obese and overweight category can be considered. This study can be done over a longer duration to assess the long-term benefits, especially for chronic snorers.

Conclusion

Based on the findings of both the Wilcoxon Signed Rank Test and the Mann-Whitney U test, it is evident that both the Experimental Group (oropharyngeal exercise and the side-lying position) and the Control Group (side-lying position) experienced significant reductions in both ESS & SSS outcomes from pre-test to post-test. Specifically, the experimental group exhibited remarkable changes in both ESS and SSS scores due to the oropharyngeal exercise intervention, as indicated by the Wilcoxon Signed Rank Test. Additionally, the Mann- Whitney U test revealed a remarkable change in the experimental group and the control group regarding the reduction in ESS scores, suggesting that the treatment intervention possesses a more pronounced outcome on decreasing ESS scores than the control group. However, while the reduction in SSS scores also showed a trend toward significance between the groups, it did not reach the same level of statistical significance as the reduction in ESS scores. In conclusion,

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the findings suggest that the oropharyngeal exercise and side-lying position intervention effectively reduced snoring and daytime sleepiness and improved quality of life, as measured by both ESS and SSS scores, with a greater impact observed on ESS scores than SSS scores.

Conflict of Interest: None

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: None

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