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Effect of with-dog walking exercise on chronic subjective tinnitus in patients with obstructive sleep apnea: A randomized controlled trial

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ABSTRACT

Objectives: Obstructive sleep apnea (OSA) is a documented risk factor for the development of chronic subjective tinnitus (CST). Exercise – as a part of lifestyle changes – is highly recommended in treating OSA or CST. With-dog walking (WDW) is a low-intensity form of physical activity that does not demand specialized equipment and/or treadmill, facilities, or previous training. This study investigated the additive effect of WDW to a 12-week low-calorie diet on CST in patients with OSA.

Materials and methods: This WDW trial was designed with a randomized controlled style. OSA patients (n = 40) with CST recruited from a local Egyptian hospital were randomly divided equally into the WDW group or control group. Both groups adhered to 12-week nutritional restriction. WDW group received a 30-minute WDW program thrice weekly. Besides the 42- item depression, anxiety, and stress scales, the following items were assessed: tinnitus handicap inventory, waist circumference, apnea-hypopnea index, the visual analogue scale (VAS) of tinnitus loudness, Epworth sleepiness scale, Pittsburg sleeping quality index, the VAS of tinnitus-associated discomfort, and body mass index.

Results: All assessed significantly improved in both groups, but the WDW group's improvements were high.

Conclusions: Compared to nutritional restriction alone, the combined program of 12-week nutritional restriction and WDW produced a more significant improvement in the severity of CST and OSA.

Keywords: walking, aerobic exercise, dog walking, tinnitus, apnea

INTRODUCTION

Obstructive sleep apnea (OSA) is intermittent pauses of breathing that cause hypoxia during patients' sleep. OSA is the most common and prevalent sleep/respiratory disorder among obese middle-aged or older subjects [1, 2]. An accumulated body of evidence documents OSA as a risk factor for the development of tinnitus, especially the chronic subjective form [3-5].

Chronic subjective tinnitus (CST) is the perception of phantom (unreal) sounds in the patient's ear(s) without identifiable causes [6]. These sounds are repeated for at least ≥ six months in chronic conditions in the absence of internally- or externally-induced stimulating factors [7, 8].

A very recent published study in 2025 detected that the overall CST in OSA patients is 16.5% [5]. The specific mechanism explaining the high prevalence of CST among OSA patients is unclear. Elevated sympathetic activity, aging, and OSA-associated chronic systemic inflammation may be a

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suggested mechanism for the development of tinnitus in the OSA population [4].

It was suggested four probable hypotheses for the development of tinnitus among OSA patients as follows: OSA may cause gradual hearing loss that may provoke tinnitus, OSA-associated snoring may directly affect auditory organs/tissues and evoke CST, OSA-low quality of sleep may cause/aggravate symptoms of tinnitus, and sounds originating from OSA-treating machine (continuous positive airway pressure machine) applied during night sleeping may cause CST [9].

Tinnitus [10] or OSA [11] is a frustrating problem for any patient because the presence of both problems in the same patient is highly associated with depression, stress, anxiety, and low sleep quality [4] due to the partial ineffectiveness, high cost, and side effects of available medical therapies for OSA [1] or tinnitus [10].

Low efficacy of pharmacological agents used to treat CST [10] or OSA [11] may force patients to use complementary therapies [10, 11]. The lifestyle modification by diet restriction alone or combined with an increase in energy expenditure is a highly recommended treatment of obesity-associated CST [12, 13] or OSA [14].

Adding exercise, especially unsupervised/supervised walking to dietary restricting approaches is highly recommended in the treatment of obese subjects with OSA [15] or tinnitus [12, 13].

Involving an individual in a structured exercise on a regular basis is important to improve physical, psychological, and health-related outcomes [16-18]. Unfortunately, exercise therapists perform substantial/great efforts to enhance the exercise-associated low motivation, or to aid exercising subjects handle more correctly aversive exercise-related sensations (boredom, pain, or effort) [19].

Walking with a dog is a recognized and interesting tool used to increase adherence to physical activity and motivation during walking [20]. Compared to people who did not walk with dogs, it was documented that walking with dog (or dog ownership) is highly associated with improved psychological status, total walking time [21], sleep parameters (quality and length), body mass index (BMI), physical pains [22], and general health problems [23].

Despite its great benefits, less research is conducted to assess the efficacy of with-dog walking (WDW) in chronic diseases. This study was the first one aimed to examine the effect of WDW on tinnitus severity, psychological aspects, anthropometric parameters, sleep quality, and apnea-hypopnea index (AHI) number of sleep-related events of apnea and hypopnea) in obese patients with CST and OSA.

MATERIALS AND METHODS

Design

This WDW trial was a randomized controlled trial.

Settings

Guidance invitations containing details of this scientific research to be carried out on CST patients with OSA were fixed on the walls of the outpatient clinics of otolaryngology and chest diseases at a local general hospital. To conduct the intervention (a program of 12-week walking with a dog), the designed period for this action started from 12th December 2024 to 15th May 2025. This trial was registered on www.clinicaltrial.gov. This trial's registration ID is NCT06803095. Badr University academic ethical approval was obtained (IR00014233-18). The date of ethical approval was 10 December 2024.

Inclusion Criteria

Patients with mild OSA were involved. The total patients' number is forty. Patients were diagnosed with mild OSA by having an AHI equal to 5-15 events/hour. All patients were diagnosed by ENT physician that they had a bilateral CST. Before the involvement in this trial, the complaint of tinnitus lasted for ≥ 6 months. Patients who refused continuous passive airway pressure treatment as a therapeutic option for OSA were included. Also, patients who preferred lifestyle changes as a treatment of CST and OSA were included. All included CST patients were from both sexes. The involved OSA and CST patients had a BMI > 30 kg/m^2 to < 40 kg/m^2. The CST and OSA participants' ages ranged from 31 to 51 years old.

Exclusion Criteria

Females who reported pregnancy or lactation were excluded. Patients who had pet allergies were excluded. Patients who complained of other chest diseases like bronchial asthma, chronic obstructive pulmonary disease, etc were excluded. Patients who showed unfamiliarity or refusal to the idea of WDW were ruled out. Patients who adhered to continuous passive airway pressure or lifestyle changes in the last six months were ruled out. CST patients with OSA who adhered to antipsychotics, antihypertensive drugs, anti-obesity medications, illegal drugs, or sleeping pills were deferred from participation in this research. Patients with low back or lower limb pains originating from bony, muscular, rheumatologic, or neurologic pathologies were excluded. Patients with systemic, autoimmune, metabolic, renal, or hepatic pathologies were ruled out. CST patients with OSA who reported smoking or alcoholism were excluded.

Randomization

The distribution of patients in this study was purely random into two groups, a with-dog-walking group (WDWG) (n = 20) or a control group (n = 20). The distribution and the tracking of patients during this 12-week study is presented in **Figure 1**. This research's randomization was done using a computer list that was created by a person who was not related to the research. While the two groups followed a weight-loss diet (low-calorie diet [LCD]), WDWG received an additional program aiming to increase patients' physical activity by 30-minute WDW three times weekly.

Details of Low-Calorie Diet

To follow our designed 12-week LCD plan, the total energy intake of patients was assessed by subtracting 500 kcal/day from detecting patients' basal metabolic rate. This rate was gained from Harris-Benedict. The total energy intake-related macronutrients in the LCD plan were divided as follows: fats' represented ratio was 20-30%, proteins' represented ratio was 10-15%, and carbohydrates' represented ratio was 55-65% in addition to the recommended intake of dietary fibers, fruits, and vegetables [24, 25].

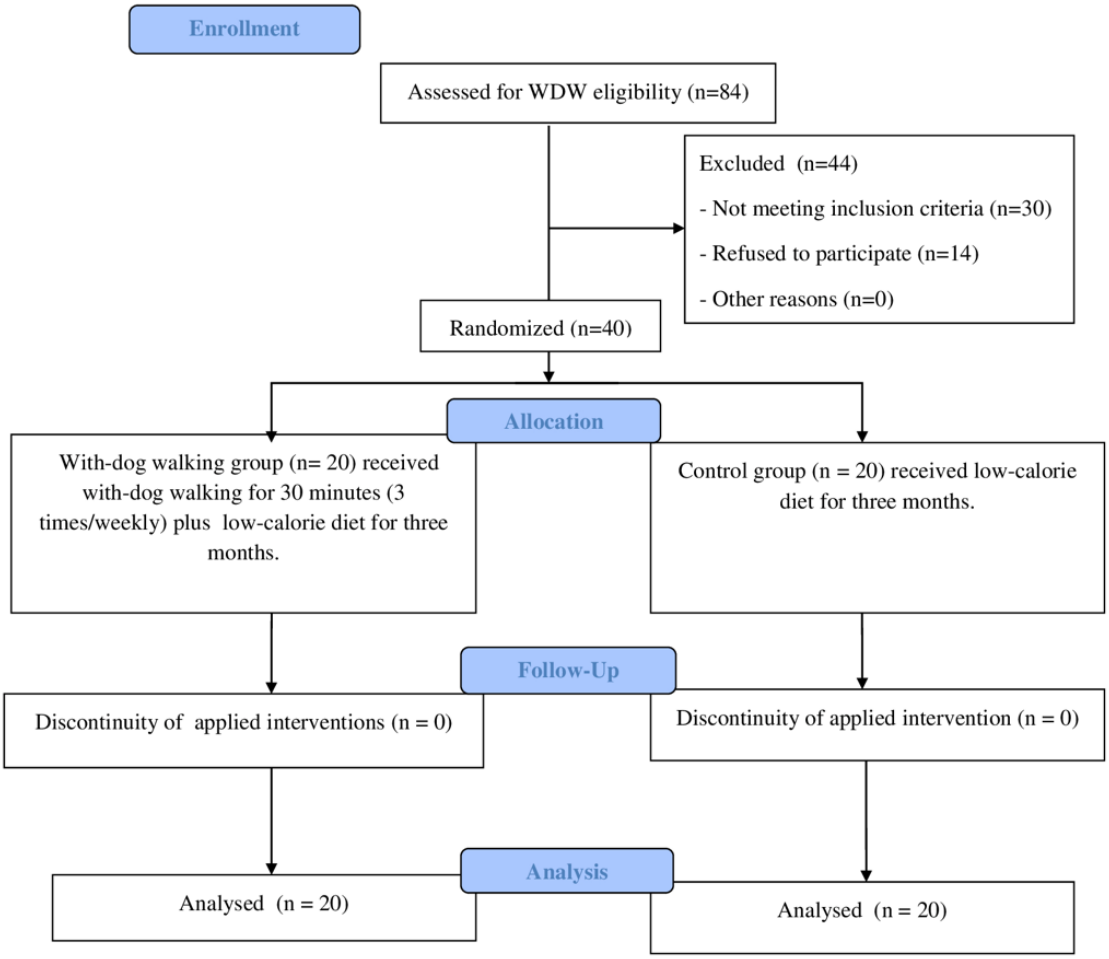


Figure 1. Flow chart of WDW chart (the authors' own elaboration)

With-Dog Walking Intervention

The authors of this study preferred to use Lulu dogs in this walking trial. Lulu dogs, also known as Pomeranian dogs, love to have a lot of fun while playing with others. This type of dog is calm, beautiful in shape, small-sized, intelligent, light weighed, friendly, lovely, playful, and never gets bored from outdoor walking. Besides their quick ability to be trained on commands and names, this type of dog is not ferocious or truly aggressive, so authors involved this type of dog in this study.

Each patient was assigned to a Lulu dog to participate in this study. Before starting the WDW program, for a period of a month, the idea of sitting with the dog for two hours in the nearest sports club was approved to increase the familiarity between the patient and the dog (these two hours were not interrupted by any motor activity by the patient). These funny hours spent with the dog took place daily in the presence of a dog trainer. To be noted, the weight of participating dogs ranged from 1.8 and 3.5 kilograms. Also, the height of participating dogs ranged from 18 to 30 cm at the shoulder.

The dogs used in this study were examined by a licensed veterinarian to rule out skin diseases, parasites, or any infections that they might transmit to patients. Any dog that might suffer from any health problems was also excluded. Every dog that participated in the WDW had a health certificate from the local veterinary authorities indicating that it received veterinary vaccinations or serums regularly.

Five-minute warm-up stretching exercises for lower limb muscles were conducted before starting The WDW program. The same exercises were performed after the 30-minute WDE as cooling down. Every patient wore a wristwatch that contained a heart rate monitor. Every patient was ordered to track his heart rate to keep his/her 30-minute WDW intensity around 50-60% of his maximal heart rate

Primary Outcome

Tinnitus handicap inventory

The questionnaire that examined the affection of life quality by CST was tested by the 25-item THI. This type of questionnaire was responded to by all patients with OSA and CST. The response to every item was as follows: zero (means no), two (means sometimes), or four (means yes). The collection of low scores of tinnitus handicap inventory (THI) after the WDW program was a good improvement [7].

Secondary Outcomes

Loudness of chronic subjective tinnitus

The loudness of CST was assessed by a 10-cm horizontal line (visual analogue scale [VAS]). The collection of a low score of VAS-assessing CST loudness after the WDW program was a good improvement [7].

Chronic subjective tinnitus -induced discomfort

CST-induced discomfort was assessed by a 10-cm horizontal line (VAS). The collection of low scores of VAS-assessing CST-induced after the WDW program was a good improvement [7].

Table 1. OSA patients with subjective tinnitus (participants' basic/clinical variables)

Data	WDWG	Control group	p
Age of tinnitus participants with OSA (years) (M ± SD)	40.35 ± 5.16	41.20 ± 6.49	0.649
BMI of tinnitus participants with OSA (kg/m^2) (M ± SD)	34.61 ± 2.12	35.58 ± 1.69	0.118
Neck circumference of tinnitus participants with OSA (cm) (M ± SD)	40.45 ± 2.91	40.05 ± 2.98	0.670
WC of tinnitus participants with OSA (kg/m^2) (cm)	115.85 ± 8.22	117.75 ± 7.89	0.461
Duration of tinnitus in OSA participants (months)	42.05 ± 5.15	42.25 ± 5.67	0.907
Sex distribution of tinnitus participants with OSA (number of men and females, respectively, assessed via Chi-square test)*	13:7	15:5	0.490
Apnea hypopnea index of tinnitus patients with OSA (events/hour)	11.85 ± 1.81	12.60 ± 2.28	0.257

Note. M: Mean; SD: Standard deviation; All p values are non-significant

Apnea-hypopnea index

The value of AHI in all patients with CST and OSA was assessed via a computerized polysomnogram Somno device/unit, Somnomedics, made in Germany). The collection of low scores of AHI after the WDW program was a good improvement.

Epworth sleepiness scale

Every item of the 8-item Epworth sleepiness scale (ESS) was scored from 0 to 3. The total score of ESS responded to by every patient with CST and OSA ranged from 0-24. ESS assessed patients' subjective daytime sleepiness during different daily activities. The collection of a low score of ESS after the WDW program was a good improvement [26].

Pittsburgh quality of sleep index

Every item of 19-item Pittsburgh quality of sleep index (PSQI) was scored from 0 to 3. The total score of PSQI responses by every patient who complained of CST and OSA ranged from 0-21. PSQI assessed patients' subjective quality of sleep. The collection of a low score of PSQI after the WDW program was a good improvement [27].

Anthropometric measures

The anthropometric measures, BMI and waist circumference (WC), were examined in all patients with CST and OSA.

Depression, anxiety, stress scales

Three subscales constituted this 42-item popular questionnaire. A separate scale was built within the depression, anxiety, stress scales (DASS) for assessing separate psychological symptoms; depression, anxiety, and stress, respectively. Each scale contained 14 items. Every item of the 42-item DASS was scored from 0 to 3. The authors statistically analyzed the total score of summed three subscales with a score ranging from 0-126. The collection of a low score of DASS after the WDW program was a good improvement [27].

Blinding

Treatment data/details were not supplied to assessors of AHI, VAS-assessing loudness of CST, ESS, DASS, VAS-assessing CST-induced discomfort, WC, BMI, PSQI, and THI.

Power Analysis

The THI parameter's effect size (1.05) was detected by G*power analysis. This analysis was applied to 16 patients with OSA and CST (this number of patients served as a pilot-test maneuver to complete this power analysis and to provide the total number of patients (n = 32) needed to finalize this study). For patients' dropout avoiding procedure, the patients' number was increased to forty participants.

Statistical Analysis

The statistical test used in outcomes' curation and interpretation was the analysis of variance test (assessed changes in outcomes with or between groups). The statistical test used in basic variables' curation and interpretation is the unpaired test (assess the pre-treatment significant difference of age, duration of CST, or neck circumference between groups). The statistical test used in the curation and interpretation of any difference related to between-group pre-treatment sex distribution was the Chi-square test. All statistically managed tests were applied with a p value < 0.05. The selected tests were statistically used/chosen due to the normal distribution of all data. The Kolmogorov-Smirnov test was the test that confirmed this normal distribution.

RESULTS

No reported significant difference was tracked during the resultant interpretation of pre-treatment comparison between groups' basic data (age, duration of CST, sex distribution, and neck circumference) (**Table 1**) or assessed outcomes (AHI, VAS-assessing loudness of CST, ESS, DASS, VAS-assessing CST-induced discomfort, WC, BMI, PSQI, and THI) (**Table 2**).

Both groups showed significant improvements in all the post values of examined outcomes (AHI, VAS-assessing loudness of CST, ESS, DASS, VAS-assessing CST-induced discomfort, WC, BMI, PSQI, and THI). The track of all outcomes' improvements was higher in the WDW group (**Table 2**).

In favor of the WDW group, a reported significant difference was tracked during the resultant interpretation of post-treatment comparison between groups' assessed outcomes (AHI, VAS-assessing loudness of CST, ESS, DASS, VAS-assessing CST-induced discomfort, WC, BMI, PSQI, and THI) (**Table 2**).

DISCUSSION

This study was the first one that used the WDW program to improve OSA and OSA-induced CST in adults. The use of WDW in clinical research is very limited. Published literature focused its content on the positive effects of dog ownership or WDW on increasing physical activity and psychological status in older adults.

Walking is an accessible, popular, and common activity applied by subjects during their leisure time. It is recommended that this activity must be performed for thirty minutes three times per week. Walking can be applied in the open air or on treadmills present in home or gym settings but this activity is usually faced by boredom and discontinuity [23]. Walking with a dog seems to be more pleasurable compared to

Table 2. Outcomes of tinnitus patients OSA (M ± SD)

The measured data	M ± SD		p-value (between groups)
	WDWG	Control group	
THI of OSA patients			
Pre 12-week with-dog walking	43.60 ± 8.29	45.60 ± 7.91	0.440
Post 12-week with-dog walking	29.50 ± 7.36	40.80 ± 7.95	< 0.001*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
VAS of tinnitus-related discomfort of OSA patients (cm)			
Pre 12-week with-dog walking	7.87 ± 1.25	8.02 ± 1.50	0.743
Post 12-week with-dog walking	6.35 ± 1.02	7.44 ± 1.38	0.007*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
VAS of tinnitus loudness of OSA patients (cm)			
Pre 12-week with-dog walking	7.66 ± 1.19	8.43 ± 1.26	0.054
Post 12-week with-dog walking	5.54 ± 1.06	7.89 ± 1.18	< 0.001*
p-value (within groups complain OSA and tinnitus)	< 0.001*	0.009*	
BMI of patients with tinnitus and OSA (Kg/m^2)			
Pre 12-week with-dog walking	34.61 ± 2.12	35.58 ± 1.69	0.118
Post 12-week with-dog walking	32.66 ± 2.14	34.55 ± 1.86	0.005*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
WC of patients with tinnitus and OSA (cm)			
Pre 12-week with-dog walking	115.85 ± 8.22	117.75 ± 7.89	0.461
Post 12-week with-dog walking	107.65 ± 8.72	113.35 ± 7.80	0.036*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
Apnea hypopnea index of tinnitus patients with OSA (events/hour)			
Pre 12-week with-dog walking	11.85 ± 1.81	12.60 ± 2.28	0.257
Post 12-week with-dog walking	8.60 ± 1.81	11.45 ± 2.21	< 0.001*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
ESS of tinnitus patients with OSA			
Pre 12-week with-dog walking	8.85 ± 1.75	9.80 ± 1.57	0.08
Post 12-week with-dog walking	6.95 ± 1.63	8.70 ± 1.45	0.001*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
PSQI of tinnitus patients with OSA			
Pre 12-week with-dog walking	10.80 ± 1.96	11.90 ± 1.65	0.063
Post 12-week with-dog walking	8.70 ± 1.71	10.80 ± 1.60	< 0.001*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	
DASS (total score of 42-tem questionnaire) of tinnitus patients with OSA			
Pre 12-week with-dog walking	46.20 ± 5.19	47.40 ± 5.89	0.499
Post 12-week with-dog walking	37.05 ± 4.81	42.80 ± 5.45	0.001*
p-value (within groups complain OSA and tinnitus)	< 0.001*	< 0.001*	

Note. M: Mean; SD: Standard deviation; *The value of this symbol represents that the outcome's p-value is < 0.05 (i.e., significant)

walking performed in other settings (gym, sports club, etc) [20] because it includes the relationship with a companion animal. WDW is a low-intensity form of physical activity that does not demand specialized equipment and/or treadmills, facilities, or previous training [28].

There is strong documented evidence that dog ownership or WWD can introduce vital merits in terms of motivating persons to adhere to a designed walking program. Walking with dogs enhances walking behavior, time of performing physical activity, social interaction, and emotional status [23], hence depression, anxiety, stress, competence, and self-esteem improve [29].

Supporting us, compared to non-dog owners or dog owners who did not walk regularly with their dogs, regular walkers with dogs had significantly lower depression [21], insomnia, and BMI [22]. Supporting us, a study published in 2017 reported that WDW was associated with lower BMI, fewer limitations of daily living activities, fewer medical visits, and higher energy expenditure [28].

Oppositely, in a 2-year follow-up study aimed to assess the relation between mental health and period of dog ownership and/or WDW, no reported statistically significant/documented effects were noticed over time between dog ownership, WDW, and mental health (stress or depression) [30]. Also, levels of depression and stress in patients with ischemic heart disease have not been affected by dog ownership because the tested patients reported that they spent very little time weekly waking with their dogs [31].

In the context of tinnitus complaints, physical activity is a highly recommended lifestyle change to decrease CST severity. Besides the reported increase of cochlear blood flow and inhibited neural activity within cochlear tissues [32], exercise or physical activity distracts CST patients from severe unpleasant CST-related symptoms, depression, stress, or anxiety [33].

The prevalence of CST in persons with excessive weight (i.e., obese) is 2.4 times higher than in persons with ideal/normal body mass [34]. Excessive body mass [35] or abdominal obesity [12, 13] induce changes in cochlear tissues such as an increase in oxidative stress, elevation in the released free fatty acids, change in the balance of potential of hydrogen, consequently, tinnitus develops [35, 36]. Weight loss helps in the correction of these changes that damage cochlear tissues, hence, tinnitus-related symptoms and discomfort improve [13].

Supporting us, the performance of 2.5-hour vigorous exercise (high-intensity physical activity) or moderate activity weekly reduces the risk of having CST [37]. Lined with our results, compared to dietary restriction alone, adding 12-week physical exercise to guidelines of restricting caloric intake

produced a more significant improvement in obese patients' CST-related VAS of symptoms' severity or discomfort in addition to the improvement in BMI, depression, WC, and THI [12, 13].

The improvement of OSA in our study may be explained by the different effects of walking activity (this activity is considered a general physical exercise for all body parts). Physical exercise – a part of weight loss programs – improves the tone of upper airway dilating muscles, inhibits upper airway collapsibility induced by the accumulated pharyngeal fat deposits in patients' oropharynx, lowers OSA-associated fluid accumulation in patients' neck, alleviates hormonal dysregulation involved in OSA occurrence, declines OSA-associated systemic inflammation, improved neuromechanical control of patients' upper airway patency during their sleep, reduces daytime sleepiness, and increases sleep efficiency [38-41].

Compatible with our results, a 16-week dietary restriction significantly improved weight and AHI in obese patients with OSA [42]. Also, a systematic review reported a significant decrease in weight and AHI after dietary restriction alone or combined with exercise in OSA patients [43]. Also, despite the non-significant decline in ESS that opposed our results, the findings of AHI, body mass, and BMI supported our findings/results because there was a significant decline in these findings after a 3-month weight loss (dietary restriction) in OSA patients [44]. Lined with our reported results, a 12-week supervised aerobic exercise and dietary restriction in older adults with OSA significantly improved their AHI, weight, total sleep time, WC, and BMI [45].

Despite the decrease (significant decline) in weight, depression, and ESS, the decline in AHI did not significantly differ after the adherence to a program of dietary restriction and exercise may be due to the inclusion of a small number of patients with mild and moderate OSA [46].

Also, adding a program of lifestyle changes (nutritional restriction and aerobic exercises) to the medical treatment (continuous positive airway pressure) of OSA significantly enhanced weight, AHI, ESS, and PSQI in the treated patients [14]. Despite the significant decrease in AHI, ESS, BMI, and total sleep time did not significantly differ after the executed 12-week exercise program that contained breathing exercises and aerobic physical activities in patients with mild to moderate OSA [47].

Limitations

Future studies must cover our failure of long-term follow-up tracking to all findings (AHI, VAS-assessing loudness of CST, ESS, DASS, VAS-assessing CST-induced discomfort, WC, BMI, PSQI, and THI).

CONCLUSIONS

Compared to nutritional restriction alone, the combined program of 12-week nutritional restriction and WDW produced a more significant improvement in AHI, VAS-assessing loudness of CST, ESS, DASS, VAS-assessing CST-induced discomfort, WC, BMI, PSQI, and THI in OSA patients with CST.

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Ethical statement: This study was approved by the Scientific Research Ethical Committee at Badr University in Cairo on 10 December 2024 with approval number IR00014233-18. In line with general and internationally recognized standards (Helsinki recommendations), in conducting academic medical research, patients' consent was taken in addition to ethical approval.

AI statement: The authors did not use generative AI or AI-based tools in preparation or writing of this article.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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