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Early View

Research letter

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Benefits of Supervised Community Physical Activity in Obstructive Sleep Apnoea

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To the editor

Obstructive sleep apnoea (OSA) is a chronic disorder characterised by repetitive episodes of partial or complete airway obstruction occurring during sleep [1]. Recent data suggest that moderate to severe OSA is highly prevalent, affecting up to 50% of men and 25% of women [2]. OSA is associated with frequent cardiovascular and cerebrovascular events [3]. Although continuous positive airway pressure (CPAP) is the gold standard treatment, long-term adherence remains poor, particularly in moderate and in non-sleepiness patients [4], while the cardiovascular risk remains high.

Exercise has recently gained attention by improving apnoea-hypopnoea index (AHI), daytime sleepiness, and quality of life [5-8]. However, previous studies had several drawbacks including small sample size, too specific populations, lack of randomisation and short-term follow-up, while OSA patients need long-term management.

Therefore, the aim of the present randomised controlled trial (RCT) was to assess the effectiveness of a 9-month outside the hospital exercise program as a treatment for moderate OSA, defined by reaching an AHI<15 at follow-up.

Between June 2015 and September 2017, we screened 595 participants from the general population as well as 30 from the Sleep Laboratory of the University Hospital of Saint-Etienne - France. Eligible criteria were an AHI ranging 15-30 and age 40-80 years. Exclusion criteria were: being currently treated for OSA; cardiovascular or respiratory comorbidities and/or Epworth Sleepiness Scale (ESS) score >10 justifying immediate initiation of CPAP; respiratory or heart disease discovered during stress testing contraindicating exercise; and Parkinson's disease. The study was approved by an institutional review board (CPP Sud-Est 1 #1508033, France) and registered with ClinicalTrials.gov (NCT02463890).

Eligible patients were randomly assigned to the exercise or to the control group after obtaining written inform consent. Patients randomised in the exercise group were enrolled in an exercise program (*NeuroGyV*) performed in clubs of a non-competitive Sports Federation, the French Federation for Physical Education and Voluntary Gymnastics (FFEPGV). The program combined three different supervised sessions of exercise per week during the nine months of the FFEPGV annual activity: nordic walking, aquagym and gymnastic. Each session lasted 60 minutes, including 10 minutes of warm-up, 40 minutes of combined resistance and aerobic exercises at the anaerobic threshold, and 10 minutes of cool-down, complying with public health recommendations. Control

group participants attended two group educational sessions about healthy diet and physical activity recommendations.

All patients underwent a polygraphic recording (Nox T3, Nox Medical, Reykjavik, Iceland) at baseline and 9 months. Examinations were manually scored twice according to the 2012 AASM criteria [9], by a single scorer blinded to treatment assignment and OSA severity was defined as mild (5≤ AHI <15), moderate (15≤ AHI <30), or severe (AHI ≥30). A maximal cardiopulmonary exercise test (CPET) was performed on a cycloergometer including breath-by-breath respiratory gas exchange measurements (Jaeger Vyntus CPX, CareFusion, Hoechberg, Germany). Medical history was recorded and anthropometric data measured. Daytime sleepiness was assessed using the ESS and subjective sleep quality with the Pittsburgh Sleep Quality Index (PSQI); daily physical activity was evaluated with the Population Physical Activity Questionnaire (POPAQ) [10].
With a 80% power and a 0.05 alpha level, 48 participants per group were required to detect a 30% treatment efficacy in the exercise group and 5% in the control group, assuming a 10% attrition rate. All analyses were conducted in intention-to-treat (ITT) using IBM-SPPS Statistics 24.0 (Armonk, N.Y., USA). Data are presented as mean±SD and frequencies.

We included 96 patients (mean age 63±7 years, mean body-mass index [BMI] 28.5±4.2 $kg.m^{-2}$, 61% male, 71% hypertensive and 19% diabetics); 88 patients completed follow-up visits at 9 months. No significant differences were observed between groups for any of the baseline characteristics. No adverse events occurred. The average exercise attendance was 61 out of the 88 prescribed sessions (median, 76%; IQR, 63-88).

A significantly higher proportion of patients in the exercise group (25 of 43, 58%, 95% CI 43–74) reached an AHI<15 after 9 months compared to the control group (9 of 45, 20%, 95% CI 8-32) (chi-square: p<0.0001). The significant effect of exercise remained after adjustment for age, sex, baseline BMI, AHI and MVPA (p<0.0001). None of the patients reached an AHI<5.

Compared to controls, the exercise group demonstrated a significant decrease in AHI (-18% vs. +6%; p=0.007). Other parameters of OSA improved as well in the exercise group while oxygen saturation (SpO_2) parameters worsened in the control group (Table 1). Supine time during sleep did not change in any group (p=0.39). Clinically, the exercise group showed a significant drop in ESS and PSQI scores compared to the control group

in which sleep quality worsened. Interestingly, the intervention effect was significantly greater in obese patients compared to patients with a BMI<30 after adjustment for initial AHI (p=0.037).

Peak oxygen consumption increased in the exercise group compared to controls on CPET, along with anaerobic threshold and peak oxygen pulse (Table 1). Both MVPA and total daily energy expenditure increased in the exercise group.

Although weight and BMI were stable in both groups, neck circumference increased in the control group while waist-to-hip ratio decreased in the exercise group (Table 1).

Overall, we showed that 58% of the moderate OSA patients reached an AHI <15 in response to a 9-month supervised community physical activity program. However, the 4.1 AHI reduction we found in ITT with exercise was lower than previously reported. This may be explained by more severe OSA in other trials [7, 8], major obesity, or younger age [5]; some trials also included dietary interventions in the exercise group [8], which may catalyze the favourable effect of exercise training. Interestingly, our per protocol analysis demonstrated an AHI improvement reaching -6.2±7.5 events/h which was consistent with results of a previous meta-analysis [11].

By contrast, OSA spontaneously increased in controls after 9 months, as evidenced by a higher time spent with an SpO_2 <90% and lower mean SpO_2, two independent predictors of sudden cardiac death [12].

The strength of our trial lies in the 9-month management outside the healthcare sector as compared to previous studies designed on shorter periods in hospital settings [5, 6, 8]. It is worth noting that the improvement in maximal oxygen uptake suggests benefits in cardiovascular risk reduction and life expectancy improvement [13], whereas recent studies revealed that CPAP therapy alone does not prevent cardiovascular mortality [14].

The main limitation of our study was the OSA assessment on a single night upon inclusion and follow-up, which may have introduced additional variability [15], even though it remains a standard. Moreover, participants were aware of their intervention assignments and some patients randomised in the control group may have trained independently which, however, would have reduced the magnitude of the effects of the program we observed.

Our exploratory analyses revealed that the exercise effect was greater in obese patients, suggesting a potential role of change in pharyngeal fat mass distribution through exercise training which may contribute to reduce OSA severity in obese patients, although this was not assessed in the present study.

In conclusion, long-term physical activity programs in real life community settings may help improve moderate OSA, although AHI improvement remains modest. Obese patients are probably the best candidates to such programs.

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Table 1. Group comparisons of sleep, exercise and anthropometrics parameters at baseline and change at nine months.

	Control (N=45)		Exercise (N=43)		Between-group difference	P value
	Baseline	**Change at 9 months**	**Baseline**	**Change at 9 months**		
Sleep parameters						
AHI, events/h	20.7 ± 6.1	1.2 ± 8.0	23.1 ± 8.0	-4.1 ± 9.7**	-5.3 ± 8.8	**0.007**
Obstructive, events/h	5.8 ± 4.2	1.4 ± 5.5	7.8 ± 6.4	-1.4 ± 6.4*	-2.8 ± 5.9	**0.016**
Central, events/h	1.1 ± 1.9	0.1 ± 1.9	1.2 ± 2.4	0.2 ± 1.9	0.1 ± 1.9	0.990
Hypopnoea, events/h	13.9 ± 5.3	-0.3 ± 5.5	13.9 ± 4.3	-2.7 ± 6.3**	-2.4 ± 5.9	0.064
Supine time, % TST	33.8 ± 26.4	-3.2 ± 24.2	37.2 ± 25.9	-8.2 ± 26.1	-5.0 ± 25.1	0.389
ODI, events/h	21.6 ± 7.3	0.8 ± 8.2	22.7 ± 8.4	-2.2 ± 9.1*	-3.0 ± 8.6	0.116
Mean SpO_2, %	92.4 ± 1.7	-0.6 ± 1.2**	92.1 ± 1.3	-0.3 ± 1.2	0.3 ± 1.2	0.342
Time SpO_2<90%	11.6 ± 17.5	4.5 ± 18.4**	10.5 ± 11.4	1.0 ± 14.5	-3.5 ± 16.5	**0.036**
ESS score	7.4 ± 4.3	-0.1 ± 3.2	8.4 ± 4.4	-1.8 ± 4.1**	-1.7 ± 3.6	**0.042**
PSQI score	7.0 ± 3.3	0.8 ± 2.4*	7.4 ± 3.7	-0.6 ± 2.8	-1.4 ± 2.6	**0.015**
Exercise and anthropometrics parameters						
Peak VO_2, ml/min/kg	22.8 ± 5.7	0.3 ± 2.4	23.6 ± 6.0	2.3 ± 3.1***	2.0 ± 2.7	**0.001**
VO_2 at VT, ml/min/kg	17.4 ± 4.1	-0.4 ± 3.6	18.2 ± 5.0	1.8 ± 4.2**	2.4 ± 3.9	**0.001**
O_2 pulse, ml/bpm	12.7 ± 3.1	0.5 ± 1.5	13.4 ± 3.3	1.4 ± 1.7***	0.9 ± 1.6	**0.031**
Sedentary, min/day	489 ± 168	-2 ± 158	497 ± 220	-11 ± 131	-9 ± 145	0.758
Light PA, min/day	261 ± 118	-4 ± 123	238 ± 109	-3 ± 64	1 ± 94	0.667
MVPA, MET-min/week	2898 ± 2087	79 ± 1109	3295 ± 2326	795 ± 1841***	716 ± 1467	**0.002**
DEE, KJ/24h	11556 ± 1699	-25 ± 846	11676 ± 2008	273 ± 963**	298 ± 903	**0.047**
Body mass index, kg/m^2	28.3 ± 4.3	0.1 ± 0.9	28.5 ± 4.1	-0.1 ± 0.9	0.2 ± 0.9	0.422
Waist circumference, cm	97.9 ± 12.0	1.4 ± 3.1**	100.7 ± 12.6	0.1 ± 2.9	-1.3 ± 3.0	0.060
Waist to hip ratio	0.94 ± 0.08	0 ± 0.05	0.97 ± 0.08	-0.02 ± 0.03**	-0.02 ± 0.04	0.067
Neck circumference, cm	37.7 ± 3.6	0.8 ± 1.1***	38.8 ± 3.3	0.3 ± 1.2	-0.5 ± 1.1	**0.028**

Definition of abbreviations: AHI = apnoea-hypopnoea index; DEE = daily energy expenditure; ESS = Epworth Sleepiness Scale; MET = Metabolic Equivalent of Task; MVPA = moderate to vigorous physical activity; O_2 = oxygen; ODI = oxygen desaturation index; PA = physical activity; PSQI = Pittsburgh Sleep Quality Index; SpO_2 = pulse oxygen saturation; TST = total sleep time; VO_2 = oxygen consumption; VT = ventilatory threshold.

Data are presented as mean ± SD. Significant changes from baseline values to 9 months within groups: $^{*}p<0.05$; $^{**}p<0.01$ using paired *t*-test or Wilcoxon signed-rank test as appropriate.

Differences in changes from baseline between groups were calculated using independent Student's *t* test or Mann-Whitney U test as appropriate. Significant between-group differences are highlighted in bold.