



Short communication

The effect of physical strain on breeders patients with obstructive sleep apnea syndrome



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ABSTRACT

Aim: The purpose of this study was to investigate the cardiopulmonary exercise testing (CPET) in breeders patients with obstructive sleep apnea syndrome (OSAS).

Method: Thirty-two male participants (Age: 42.2 ± 7.3 yrs, BMI: 29.5 ± 2.2 kg/m²) underwent full overnight polysomnography (PSG) and were divided into two groups (OSAS group: n = 20 vs. Control group: n = 12). 72-hours after the PSG study, they were subjected to CPET. The Independent *t*-test was used to measure the differences between the groups. Pearson's correlation coefficient was used among the parameters of CPET and PSG study.

Results: The results showed difference between the groups (OSAS vs. Control) during CPET in end-tidal, CO₂ pressure in the peak of the exercise (38.7 ± 3.0 vs. 35.4 ± 5.5 mmHg, *p* = 0.031) and mean arterial pressure (122.7 ± 10.6 vs. 113.7 ± 11.8 mmHg, *p* = 0.035). Correlation results showed differences between the physical strain and the polysomnography study in physical strain parameters “walking duration per day with the herd” and oxygen desaturation index during sleep (*r* = 0.370, *p* = 0.037) and minimum oxygen saturation during sleep (*r* = -0.374, *p* = 0.035), in the parameter “milking duration” and apnea (*r* = 0.392, *p* = 0.048), AHI (*r* = 0.374, *p* = 0.035) and oxygen desaturation index during sleep (*r* = 0.434, *p* = 0.013). The physical strain parameter “working hours per day” wasn't related to any parameter of the polysomnography study.

Conclusion: The daily physical activity may have a protective role during the course of the disease in patients with OSAS.

1. Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by recurrent upper airway collapse during sleep, leading to intermittent nocturnal hypoxia and sleep fragmentation. OSAS symptomatology appears as a reduction (hypopnea) or complete cessation (apnea) of airflow through the airways despite continued respiratory efforts. OSAS is diagnosed by clinical history and polysomnography (PSG). OSAS is classified by an apnea–hypopnea index (AHI > 15/h⁻¹ or an AHI > five with daytime and night-time symptoms. The apnea severity is classified as mild (AHI 5–15/h⁻¹), moderate (AHI 15.01–30/h⁻¹), or severe (AHI > 30.1/h⁻¹) (Mendes et al., 2014). The patients with OSAS during ergospirometry are characterized by low aerobic capacity due to reduced physical activity related to the low quality of sleep, daytime sleepiness, and increased apnea-hypopnea index (AHI

(Stavrou et al., 2018).

The purpose of this study was to investigate the physical fitness of breeders, patients with OSAS with the ergospirometry method. We hypothesized that the daily work of the breeders requires intense physical activity, similar to low daily exercise training.

2. Method

2.1. Participants

Thirty-two male traditional breeders underwent full overnight polysomnography (PSG) in the Laboratory of Sleep Disorders (Department of Respiratory Medicine, Faculty of Medicine, University of Thessaly) for suspected OSAS (Table 1) and were divided into two groups (OSAS group: n = 20 vs. Control group: n = 12). 72 h after PSG,

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Table 1
Demographic, polysomnography, respiratory and physical strain characteristics between groups.

	OSAS group	Control group	P value
Age, yrs	45.9 ± 10.2	42.2 ± 7.3	NS
BMI, kg/m ²	30.6 ± 3.4	29.5 ± 2.2	NS
AHI, events/h ⁻¹	47.3 ± 23.2	2.8 ± 1.1	< 0.001
Apnea, events/h ⁻¹	24.9 ± 25.8	0.4 ± 0.3	< 0.001
Hypopnea, events/h ⁻¹	22.5 ± 12.7	5.7 ± 2.3	< 0.001
DI	44.8 ± 26.9	6.8 ± 5.9	< 0.001
MinSaO ₂	79.0 ± 10.6	93.7 ± 3.1	< 0.001
Sleep duration, min ⁻¹	324.5 ± 54.4	310.3 ± 54.3	NS
Epworth Sleep Scale	9.2 ± 4.7	9.3 ± 3.3	NS
FEV ₁ , % of predicted	104.2 ± 25.5	111.4 ± 11.9	NS
FVC, % of predicted	106.9 ± 27.0	111.7 ± 17.0	NS
PEF, % of predicted	113.0 ± 12.4	103.9 ± 17.1	NS
Physical strain			
working experience, yrs	25.4 ± 8.2	22.0 ± 5.9	NS
walking/day with the herd, h ⁻¹	3.4 ± 0.7	3.2 ± 0.7	NS
working, hours/day, h ⁻¹	13.7 ± 1.5	13.8 ± 0.8	NS
working, days/week, frequency	7.0 ± /	7.0 ± /	NS
milkingduration/day, h ⁻¹	2.1 ± 0.7	1.9 ± 0.5	NS

Abbreviations: AHI: apnea-hypopnea index; BMI: body mass index; DI: oxygen desaturation index during sleep; FEV₁: forced expiratory volume in 1sts; FVC: forced vital capacity; MinSaO₂: minimum oxygen saturation during sleep; PEF: peak expiratory force. Continuous variables are presented as mean ± standard deviation.

all volunteers were subjected to ergospirometry in the Laboratory of Cardio-Pulmonary Testing, (Department of Respiratory Medicine, Faculty of Medicine, University of Thessaly). All volunteers were living and raising goats and sheep, in the mountainous region of Thessaly with an altitude of 600-to-800 m above sea level. Inclusion criteria were the age, between 30-to-60 years, and the body mass index (BMI) < 35 kg/m². Exclusion criteria were comorbidity-free, the smoking habit, BMI ≥ 35 kg/m² and weekly exercise ≥ 130 min⁻¹. The study was conducted according to the Helsinki declaration for use in Human subjects and was approved by the Institutional Ethics Committee, University of Thessaly (21/09-01-2017). All the participants' informed consent was obtained.

2.2. Study protocol

All participants 72 h after PSG study were subjected to ergospirometry (electronic cycle ergometer, Ergoselect 100, Ergoline, Germany) (Wasserman et al., 2004) until exhaustion. Prior to ergospirometry, the physical strain (questionnaire) as well as the anthropometric characteristics (Norton et al., 1996), a performed pulmonary function test [forced expiratory volume in 1st s (FEV₁), forced vital capacity (FVC) and peak expiratory force (PEF) (VIASYS Health Care, Germany)] (Miller et al., 2005) were recorded, calculating as well the body mass index (BMI = kg/m²) and the body surface area [BSA = (height (cm) × weight (kg)) / 3600 ½] (Mosteller, 1987) (Table 1). Each ergospirometry trial was terminated when the participant reached symptomlimited maximum exercise (RER > 1.10, HR ≥ 80% of predicted HR_{max}, and/or plateau of oxygen consumption with increasing work load) according to ATS/ACCP (2003).

2.3. Statistical analysis

The Kolmogorov-Smirnov test was used for normality of distribution. The Independent *t*-test was used to measure the differences between groups (OSAS vs. Control). The Pearson correlation coefficient was used to associate the variables between physical strain as well as the parameters of the ergospirometry and the polysomnography study. The level of significance was set to *p* < 0.05, the data are presented as mean value and standard deviation (Mean ± SD) and the statistical

Table 2
Ergospirometry results between groups.

	OSAS group	Control group	P value
Watts	175 ± 48	185 ± 46	NS
Intensity of leg fatigue, Borg Scale	5.9 ± 1.2	6.1 ± 1.4	NS
Intensity of dyspnea, Borg Scale	2.3 ± 1.1	2.6 ± 0.8	NS
Anaerobic Threshold, % of VO _{2peak}	64.4 ± 16.5	69.4 ± 12.4	NS
VO _{2peak} , % of predicted	93.5 ± 12.4	100.7 ± 10.9	NS
VO _{2peak} , ml/min ⁻¹	2415.1 ± 543.9	2627.2 ± 563.1	NS
VCO _{2peak} , ml/min ⁻¹	2627.3 ± 631.0	2845.7 ± 667.4	NS
RER	1.1 ± 0.1	1.1 ± 0	NS
V _{Epeak} L/min ⁻¹	79.9 ± 20.1	94.8 ± 27.2	NS
P _{ET} CO _{2 peak} , mmHg	38.7 ± 3.0	35.4 ± 5.5	0.031
P _{ET} O _{2 peak} , mmHg	112.1 ± 4.0	115.4 ± 5.2	NS
SpO _{2 peak} , %	97.3 ± 1.1	97.7 ± 0.9	NS
V _E /MVV	64.1 ± 19.1	65.3 ± 14.9	NS
HR, % of predicted HR _{max}	92.8 ± 8.9	98.2 ± 7.2	NS
MAP, mmHg	122.7 ± 10.6	113.7 ± 11.8	0.035

Abbreviations: f_B: breath frequency; HR: hear trate; MAP: mean arterial pressure; MVV: maximum voluntary volume; P_{ET}CO₂: end-tidal carbon dioxide pressure; P_{ET}O₂: end-tidal oxygen pressure; RER: respiratory exchange ratio; SpO₂: blood oxygen saturation with pulse oximetry; VCO₂: carbon dioxide output, V_E: minute ventilation; VO₂: oxygen uptake; Continuous variables are presented as mean ± standard deviation.

package SPSS 15 (SPSS inc., Chicago, Illinois, USA) was used.

3. Results

The results between groups in demographic characteristics, polysomnography study, pulmonary function parameters and physical strain showed in Table 1. The ergospirometry results between groups showed in Table 2.

Correlation results showed differences between the physical strain and the polysomnography study in physical strain parameters “walking duration per day with the herd” and oxygen desaturation index during sleep (*r* = 0.370, *p* = 0.037) as well as minimum oxygen saturation during sleep (*r* = -0.374, *p* = 0.035), in the parameter “milking duration” and apnea (*r* = 0.392, *p* = 0.048), AHI (*r* = .374, *p* = 0.035) and oxygen desaturation index during sleep (*r* = 0.434, *p* = 0.013). The physical strain parameter “working hours per day” wasn't related to any parameter of the polysomnography study.

4. Discussion

The data from the present study reveals that breeders, patients with OSAS have had higher values in maximal exercise in end-tidal CO₂ and higher values in mean blood pressure compared to the control group. A previous study reveals that patients with OSAS had higher values in end-tidal CO₂ in maximal exercise due to elimination of the extra amount of CO₂ produced during exercise (Dempsey, 2004). These findings are confirmed from our results which reveal a difference between groups in end-tidal CO₂ in maximal exercise phase (38.7 ± 3.0 vs. 35.4 ± 5.5 mmHg). This difference is probably related to lung resistance and the significantly increased elastance during obstructed breathing suggesting OSAS (Bijaoui et al., 2002). Moreover, the increased end-tidal CO₂ levels are an end product of a complex conglomerate, influenced by factors such as the severity of sleep apnea, daytime PaO₂, and blunted respiratory drive, respiratory mechanics and respiratory muscle fatigue (Kawata et al., 2007). Increased mean blood pressure was also noted among OSAS patients, compared to controls which may be related to endothelial dysfunction, or a blunted response to beta-2 receptor stimulation, mechanisms that are shown to occur in patients with sleep disordered breathing (Mansukhani et al., 2013).

Our results didn't show any difference between the groups in

parameters which relate to endurance during CPET probably due to the daily physical activity their work required. Ahonen et al. (1990) shows that the farmers used approximately the 50% of VO_{2max} in their daily work, which involves among other things the handling of feed and manure as well as tasks in dairy farming general. Farmers have a mean 1.5 h per day with vigorous or muscle strengthening exercise such as heavy carrying and lifting (Racine et al., 2012).

Previous studies reveal that physical exercise used as a complementary treatment for OSAS patients. According to Norman et al. (2000) applied in patients with OSAS, a regular exercise program of 24 weeks on 60–85% of HR_{max} (3 days per week) had a positive impact on the AHI, the aerobic capacity and the body mass index. In addition, Sengul et al. (2011) applied a 12 weeks aerobic exercise at 60–70% of VO_{2peak} (3 days per week, 60–90 min⁻¹ per session), and found in patients with moderate-to-several OSAS, a decrease in leg tiredness and dyspnea severity as an important determination of exercise capacity, increased VO_{2peak} , metabolic equivalents and maximal load value in the peak of cardiopulmonary exercise testing. Moreover, Yang et al., (2018) applied in patients with OSAS, 12 weeks exercise in anaerobic zone (3 days per week, 30 min⁻¹ per session) and showed improvement of the heart rate reserve during exercise and average SpO_2 during sleep. According to Iftikhar et al. (2014) there are significant effects of exercise on cardiorespiratory fitness, daytime sleepiness, and sleep efficiency which indicate the potential value of exercise in the management of OSAS.

5. Limitations of our study

The present study was limited by the fact that only 40-year-old Caucasians male breeders were studied and from specific non-urban areas, entailing that the results may not apply to other ethnic or age-groups. Moreover, in the patients with OSAS assessment ergospirometry was used and the arterial blood gas wasn't collected.

6. Conclusion

To conclude, data for the present study support that higher values in end-tidal CO_2 and mean arterial pressure in patients with OSAS during CPET, may explain an end-product of a complex mechanism that is affected by the severity of the disease. The daily physical activity may have a protective role in the course of the disease, as shown by the

CPET parameters that don't differ between the groups.

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