Published in final edited form as:
J Am Med Dir Assoc. 2014 ; 15(11): 844–846. doi:10.1016/j.jamda.2014.08.006.

Strength training and light physical activity reduces the apnea-hypopnea index in institutionalized older adults

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Abstract

Objectives—To determine the effect of 7-weeks of resistance training and walking on the apneahypopnea index (AHI) in institutionalized older adults compared to a usual care control group.

Design—Secondary analysis of data from a randomized controlled-trial.

Setting—Ten nursing and three assisted living facilities in Arkansas.

Participants—Institutionalized older adults.

Interventions—Exercise group (EG) performed supervised resistance training to arm and hip extensors on 3 days a week with additional 2 days a week of light walking. Usual care group (UC) participated in the usual activities provided within their living facility.

Measurements—2 nights of polysomnography before and following 7-week intervention.

Results—Adjusted means in the EG group showed a decrease in AHI from 20.2 (SD±1.3) at baseline to 16.7 (SD±0.9) at 7 weeks. Absolute strength gains were not associated with improved AHI.

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Trial Registration ClinicalTrials.gov Identifier: NCT00888706

Conclusion—Supervised resistance training and light walking reduced the severity of OSA in institutionalized older adults.

Keywords

exercise; nursing homes; sleep issues; older adults

Introduction

A large proportion of older adults in the United States reside in residential long-term care facilities and the number is expected to rise over the next few decades [1]. Obstructive sleep apnea (OSA) is a medical condition associated with cardiovascular and metabolic diseases, as well as premature mortality [2–5]. The prevalence of OSA for community dwelling older adults is believed to be 70% in men and 56% in women with progressive increases with aging institutionalized adults [6,7]. The preferred method of treatment for OSA, continuous positive airway pressure (CPAP), is effective, but owing to cost and practicality in managed care settings, CPAP sees minimal use in institutionalized geriatric patients. Indeed, there appears to be an aging dependent decline in CPAP adherence in older adults which increases the treatment burden of OSA in managed care institutions [8]. Exercise has a beneficial effect on OSA in younger, ambulatory patients with the potential for similar benefits in institutionalized older adults [9,10]. As a treatment intervention for OSA in managed care institutions, exercise is easily implemented with many desirable additional positive health outcomes; exercise is safe and cost effective, may be administrated individually or in a group setting, is beneficial in improving mobility and function, and associated with improvements in quality of life[11–13]. Previously, we examined (Citation Blinded for Review) various components of sleep continuity and architecture within this data set and now report the effects of resistance training and light walking on OSA severity as measured by the apnea-hypopnea index (AHI) in institutionalized older adults.

Methods

Study Design and Participants

The original study was a pretest-posttest, randomized controlled trial (reference blinded for review). We performed secondary data analyses that evaluated the effects of physical exercise and social activity with a control group on total nocturnal sleep time in 193 institutionalized older adults. 193 participants were randomized, but in the analyses that we present here we report data limited to the 144 who underwent an exercise intervention, either alone (n = 56) or in combination with social activity (n = 41), and a usual care control group (UC) (n = 47). The two groups undergoing exposure to exercise were combined to form an exercise group (EG) (n = 97), for further analyses. The remaining participants receiving social activity alone (n = 41) were not a focus of the current analyses.

Outcome Variables

A Grass Portable PSG Data Acquisition System (Astro-Med, Inc., West Warwick, RI) was used to collect nocturnal polysomnography (PSG) data. Sleep technicians measured the primary outcome variable AHI in participants' naturalistic sleep environment for two nights

at baseline and two nights at the conclusion of the intervention (after seven weeks). Two nights of PSG were averaged at baseline and at post-intervention to obtain the AHI. The AHI was defined as the number of apneas and hypopneas per sleep hour that resulted in ≥ 4% oxygen desaturation or an EEG alpha wave arousal.

Statistical Analysis

Descriptive statistics were used to assess the demographic characteristics of the sample. Analysis of variance or Pearson's χ^2 was used to examine demographic variables at pre-intervention. Pearson's r was used to measure the correlation between the pre- and the post-test measures. Analysis of covariance (ANCOVA) was used to test for differences in post-intervention AHI between groups using baseline AHI as a covariate. Stata/IC 10.0 and Statistical Package for the Social Sciences (SPSS) v. 11.5 were used for all analyses. For all analyses, the alpha was set at 0.05.

Results

Pre-intervention

Mean age for all the 144 participants in the secondary data analysis was 81.8±8.1 years (range 57-90 years) and 60% were female. Seventy five participants had an AHI ≥ 5 indicating the presence of OSA, while 83 (58%) had an AHI of > 15, indicating OSA in the moderate to severe range. There were no significant differences at baseline between the EG and UC groups in age, gender, care setting, MMSE, pharmacotherapy or baseline AHI.

Treatment Attendance, Adherence and Outcomes of the Exercise group

There was a total of 35 possible resistance training intervention days, and the EG participants completed 81% (29±7.2 intervention days). There was a significant improvement in the chest press 1-repetition maximum (1RM) from pre-intervention of 45.02±20.7 pounds to post-intervention of 60.9±28.1 pounds ($p < 0.001$), and the leg press 1RM from pre-intervention of 91.27±62.5 pounds to post-intervention of 128.9±76.3 pounds ($p < 0.001$) in the EG at the end of the 7-week intervention. The overall intensity of the resistance training sessions for both the chest and leg press was equivalent to approximately 86% of predicted 1RM. In addition to resistance training, the EG participated in 1-3 bouts of assisted light walking on two days of the week (5.87±6.1 minutes, 552±1014 feet, ≤ 2 METS per walking bout)[14]

Post-intervention Results on Primary Outcome Measure

When adjusted for the baseline AHI, ANCOVA showed a significant decrease in AHI for the EG compared to the control group ($F_{1,141}$=4.30; $p = 0.04$). The adjusted means showed a decrease in AHI from 20.2 (SD±1.39) to 16.7 (SD±0.96) for a group mean reduction of 17.3%. Pearson-r correlation statistic revealed no significant association of mean gains in both arm and leg 1RM strength with change from baseline in AHI (1RM Chest Press, $r = 0.15$, $p = 0.15$, and 1RM Leg Press, $r = 0.18$, $p = 0.10$).

Social Activity Group

There was a social activity alone group in the original study. Although the social activity alone group was not a focus of the present analysis, there was no significant change in AHI in the social activity alone group from baseline to 7-weeks, ($p = 0.38$), and the AHI was significantly lower at 7-weeks for the EG relative to the social activity alone group ($p = 0.03$).

Discussion

The primary finding was that a 7-week exercise intervention that consisted of weekly structured resistance training and sessions of light intensity walking, significantly reduced the severity of OSA as measured by AHI in institutionalized older adults. Further, our exercise treatment intervention significantly increased the absolute strength of the older adults in the experimental exercise group which may promote an increase in functional capacity and promote a reduction in the burden of care. The increased absolute strength was not associated with the reduced AHI, suggesting an exercise attribute other than gains in maximal physical strength altered pharyngeal airflow characteristics.

In aging, there is an inherent loss in respiratory function that centers around three primary mechanistic changes in respiration; decreased static elastic recoil of the lung, decreased chest wall compliance, and decreased respiratory muscle strength, all of which may contribute to the high prevalence rates of OSA in older adults [15]. Resistance training has the capacity to stimulate skeletal muscle and the cardiopulmonary system mechanistically and promote beneficial adaptations that in part attenuate these age related declines in respiration [16]. In addition, aging induced losses in muscular strength, power and endurance, known as sarcopenia, are also associated with a wide range of functional limitations such as frailty and reduced mobility. As a result, the managed care resident is at an increased reliance on facility staff for instrumental activities of daily living and at an increased risk for falls [15,17]. Frailty which is common in managed care institutions has been associated descriptively with higher rates of OSA, but our data are among the first to suggest potential reversibility of this effect with exercise [18]. As a more generalized intervention for sarcopenia, increasing exercise is known to offset the loss of muscle function with aging and prevent further decline in functional capacity and progression of frailty in the older adults [19]. Therefore it is plausible that the EG in our study experienced a direct benefit from the combined exercise sessions to the function of their supporting inspiratory muscles which reduced the frequency of airway collapse during sleep in addition to an increase in muscular strength.

There are a few limitations that lower the potential to clearly identify the mechanisms associated with our primary findings. First, study participants were not blinded to group assignment in the initial study; however their awareness of individual treatment arms was unavoidable within the individual community living settings. Second, although it is unlikely that changes in fat-mass were primary contributors to improved sleep time pharyngeal airflow we do not have body composition of anthropometric data to rule out the possibility. Third, we do not have any independent measures of inspiratory and expiratory airflow or

electromyography data during sleep to fully describe the respiratory adaptations from the exercise intervention.

Conclusion

In conclusion, we report that a combination weekly exercise intervention that consisted of resistance training and light walking for 7-weeks was successful in reducing the severity of OSA by 17.3% in institutionalized older adults. Further, we report that adherence was high and there were significant gains in absolute strength indicating the potential for resident acceptance in a wide range of managed care settings. Given the positive effects of exercise on OSA severity and the high adherence rate in our sample of institutionalized older adults we conclude that exercise could be effectively integrated into patient care practices and that it is likely to benefit sleep along with physical strength in the older adult residents.

Acknowledgements

Funded through the National Institute of Health (R01-007771, Richards PI) and VA HSR&D Advanced Research Career Development Award.

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