Associations of Cardiorespiratory Fitness and Muscular Strength with Sleep Apnea in Older Adults

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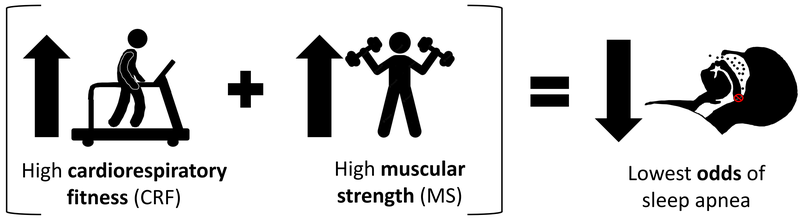
SYNOPSIS

What is already known?

What did this study find?



INTRODUCTION

- **Sleep apnea** affects ~25% of older adults, which increases CVD risk.
- While the association between **cardiorespiratory fitness** (CRF) and sleep apnea has been explored, the concurrent influence of **muscular strength** (MS) with sleep apnea is unclear.
- Therefore, we sought to assess the **independent** and **combined associations** of both CRF and MS on sleep apnea in community-dwelling older adults.

METHODS

- **Participants**: 845 older adults aged 65-95 years (58.9% female) with no history of CVD (see Table 1)
- **CRF assessment:** Time (minutes) to complete the 400m walk test, with participants subsequently categorized into age- and sex-specific tertiles of CRF performance. Faster completion times equate to higher CRF.
- **MS assessment:** Maximal relative grip strength (grip strength [kg] divided by body mass [kg]), with participants subsequently categorized into age- and sex-specific tertiles.

STATISTICAL ANALYSIS

- **Multivariate logistic regression** was used to evaluate the independent and combined associations of CRF and MS on sleep apnea, adjusting for potential confounders (see Table 2 and Figure 1).

Table 1. Participant characteristics

Characteristic	All (n=845)	Cases (n=116)	Non-cases (n=729)	*P*-value (cases Vs. non-cases)
Age, years	71.8 (5.5)	72.2 (5.9)	71.8 (5.5)	0.464
Female, *n*	498 (58.9)	51 (44.0)	447 (61.3)	**<0.001***
Body fat, %	37.0 (7.6)	37.7 (7.6)	36.9 (7.6)	0.294
Smoking status, *n*				
Never	582 (68.9)	75 (64.7)	507 (69.5)	0.529
Former	254 (30.1)	40 (34.5)	214 (29.4)	
Current	9 (1.1)	1 (0.9)	8 (1.1)	
Heavy alcohol intake[a], *n*	72 (8.5)	8 (6.9)	64 (8.8)	0.500
400m walk time, mins	4.5 (0.9)	4.9 (1.2)	4.6 (0.8)	**<0.001***
Relative grip strength[b], kg/kg	0.40 (0.11)	0.38 (0.12)	0.40 (0.11)	0.051
Meets aerobic PAG[c], *n*	649 (76.8)	79 (68.1)	570 (78.2)	**0.017***
Comorbidities, *n*:				
Hypertension	502 (59.4)	83 (71.6)	419 (57.5)	**0.004***
Diabetes	85 (10.1)	22 (19.0)	63 (8.6)	**0.001***
Asthma	62 (7.3)	11 (9.5)	51 (7.0)	0.340
COPD[d]	12 (1.4)	2 (1.7)	10 (1.4)	0.766
History of cancer, n	188 (22.3%)	30 (25.9)	158 (21.7)	0.314

Continuous data presented as mean (standard deviation), categorical data presented as count (%).
[a]Heavy alcohol intake defined as >7 and >14 alcoholic drinks/week for women and men, respectively.
[b]Average of the highest grip strength from both the left and right hands (kg) divided by body mass (kg).
[b]PAG, 2018 Physical Activity Guidelines for Americans, self-reported and defined as accumulating a minimum of 150-minutes of moderate aerobic activity/week, 75-minutes of vigorous aerobic activity/week, or an equivalent combination of the two. [d]Chronic obstructive pulmonary disease. (*) indicates $P < 0.05$.

Table 2. Odds ratios (95% confidence intervals) of sleep apnea by CRF and MS

	Total	Cases (%)	Model 1[a]	Model 2[b]	Model 3[c]
Cardiorespiratory fitness (CRF)					
Tertile 1 (Least fit)	281	64 (22.8)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Tertile 2	284	32 (11.3)	**0.43 (0.27-0.68)**	**0.53 (0.33-0.86)**	**0.54 (0.33-0.89)**
Tertile 3 (Most fit)	280	20 (7.1)	**0.26 (0.15-0.44)**	**0.36 (0.20-0.65)**	**0.38 (0.21-0.70)**
P for linear trend			**<0.001**	**<0.001**	**0.001**
Per SD			**0.56 (0.45-0.69)**	**0.66 (0.52-0.83)**	**0.67 (0.53-0.85)**
Muscular strength (MS)					
Tertile 1 (Least strong)	279	56 (20.1)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Tertile 2	286	35 (12.2)	**0.55 (0.35-0.87)**	0.64 (0.39-1.05)	0.74 (0.45-1.22)
Tertile 3 (Most strong)	280	25 (8.9	**0.39 (0.23-0.64**	0.60 (0.32-1.10)	0.74 (0.39-1.38)
P for linear trend			**<0.001**	0.071	0.286
Per SD			**0.62 (0.49-0.79)**	0.78 (0.57-1.06)	0.88 (0.64-1.21)

[a]Model 1 adjusted for age (years) and sex (male or female).
[b]Model 2 adjusted for Model 1 plus % body fat, comorbidity number (0, 1, 2, 3, or 4), history of cancer, smoking status (never, former, current) heavy alcohol intake (yes or no: >7 alcoholic drinks/week for women, >14 alcoholic drinks/week for men), meeting the 2018 aerobic physical activity guidelines (yes or no).
[c]Model 3 adjusted for Model 2 plus CRF (in the MS analysis) or MS (in the CRF analysis).

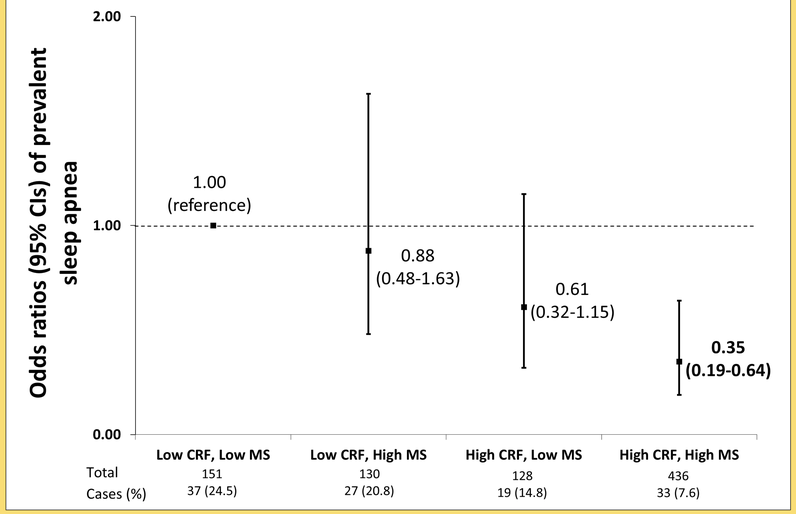


Figure 1. The combined associations of CRF and MS with sleep apnea in older adults.
Low CRF: tertile 1 of CRF distribution, **high CRF:** tertiles 2 and 3 of CRF distribution. **Low MS:** tertile 1 of MS distribution, **high MS:** tertiles 2 and 3 of MS distribution. The model was adjusted for age (years), sex (male or female), percent body fat, comorbidity number (0, 1, 2, 3, or 4), history of cancer (yes or no), smoking status (never, former, current), heavy alcohol drinking (>7 alcoholic drinks/week for women, >14 alcoholic drinks/week for men), meeting the 2018 aerobic physical activity guidelines (yes or no).

CONCLUSIONS

- **Higher CRF** was significantly associated with lower odds of prevalent sleep apnea after adjusting for MS and other potential confounders. **Higher MS** was associated with lower odds of sleep apnea after adjusting for age and sex, but this relationship was no longer significant when adjusting for CRF and other potential confounders.
- Having both **high CRF** and **high MS** was associated with the lowest odds of sleep apnea after adjusting for potential confounders, suggesting strength has a potentially additive benefit to fitness. However, **prospective studies** with larger sample sizes and an objective measure of sleep apnea (polysomnography) are needed to confirm our findings.

LIMITATIONS

- Cross sectional design (cannot prove causation).
- Predominantly white and well-educated sample (low external validity).
- Sleep apnea was self-reported (potential for misclassification bias).

PUBLIC HEALTH MESSAGE

- Being both ***fit*** and ***strong*** may be an effective approach for reducing the likelihood of sleep apnea in older adulthood.