

IMITATION OF COPD BREATHING IN HEALTHY, YOUNG INDIVIDUALS

Emma Leone, William Denton, Farahnaz Fallah Tafti, Jennifer Yentes
Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68182

INTRODUCTION

- Chronic obstructive pulmonary disease (COPD) is a chronic lung disease that is defined in terms of fixed air flow limitation. However, it is also characterized by frequent association of disease outside the lung [1,2].
- Patients with COPD have more periodic breathing patterns [3] as compared to control subjects. They also have more periodic walking patterns [4].
- Humans couple their walking and breathing patterns, called locomotor respiratory coupling (LRC). As compared to healthy controls, COPD patients exhibit abnormal LRC [5]. Their coupling is very simple (one walking stride to one breath) and it does not change with speed.
- In order to understand whether the abnormal walking or abnormal breathing causes this abnormal LRC, it is necessary to alter breathing patterns in healthy individuals.

PURPOSE:

- The main objective of this study was to determine the effect of restrictive breathing on LRC in healthy young adults.

METHODS

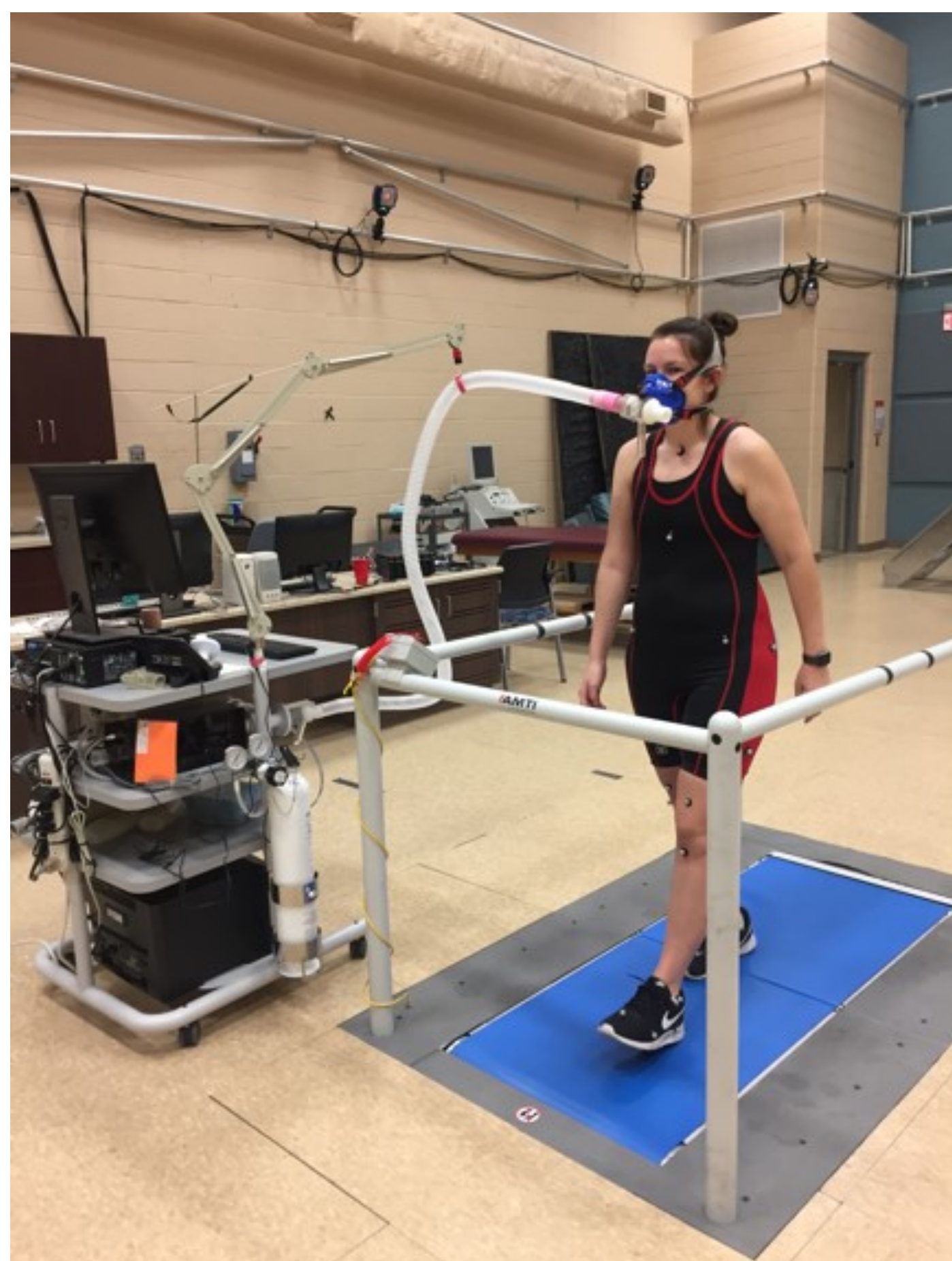


Figure 1. (left) Subject walking on treadmill with reflective markers on her body and outfitted with a restrictive breathing mask.

- Seventeen subjects participated in this study (Table 1).
- Subjects walked at their preferred speed (PS) and $\pm 20\%$ PS (Figure 1).
- Subjects walked at each speed twice, once with normal breathing via a mask, and once with restrictive breathing via a customized plug (Figure 2) inserted in the mask.
- Condition 1 was always conducted first. The other five conditions were randomized.
 - Preferred speed, normal breathing
 - Preferred speed, restrictive breathing
 - Fast speed, normal breathing
 - Fast speed, restrictive breathing
 - Slow speed, normal breathing
 - Slow speed, restrictive breathing

Table 1. Subject demographics

N	Age (years)	Mass (kg)	Height (m)
17	22.6 \pm 3.1	68.6 \pm 10.6	1.71 \pm 0.08



Figure 2. (left) 3D printed plug that was used to induce restrictive breathing.

- LRC was calculated from each of the six trials.
 - Most common used frequency ratio (MCFR) – provides a measure of the stride:breath ratio most used during the trial.
 - MCFR percentage – percentage of the walking trial where the subject's stride:breath ratio was equal to their MCFR.
 - Phase coupling (PC) – measure of the synchronization between the subject's strides and breathing. 100% is perfect coupling.
- To compare the difference of conditions within the healthy young subjects, a one-way, repeated measures ANOVA was conducted.
- A repeated measures ANOVA (3 groups x 3 speeds) was used to compare existing data from healthy older adults (N=24) and patients with COPD (N=17) were added to the data set and used to compare to healthy young adults.

RESULTS

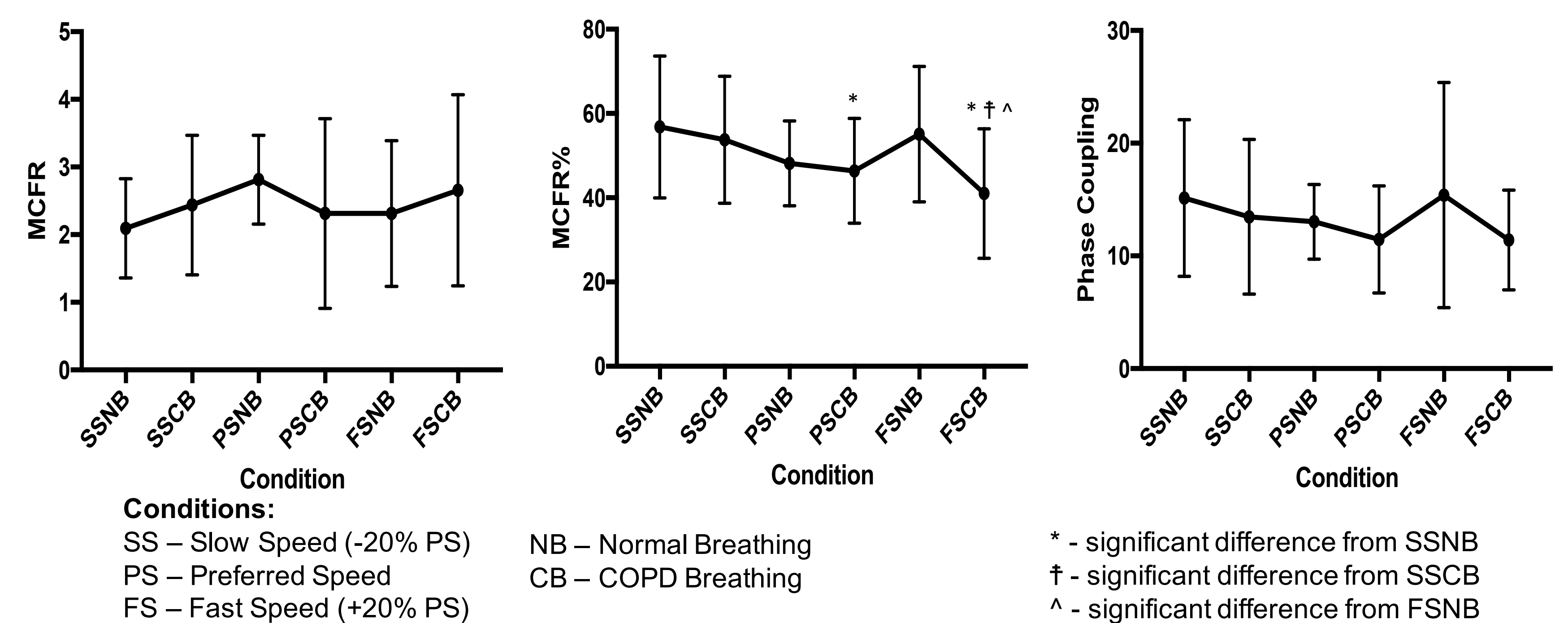


Figure 3. Comparison of MCFR, MCFR%, and Phase Coupling between walking conditions in healthy, young adults. Young subjects had less variability in their MCFR during slow walking and normal breathing, compared to preferred and fast restrictive breathing conditions ($p=0.03$). Young subjects had less variability in their MCFR during slow walking and restrictive breathing compared to fast walking and restrictive breathing ($p=0.002$) and between the two fast speed breathing conditions (NB having a greater percentage, $p=0.03$). MCFR and PC were not different between the six conditions.

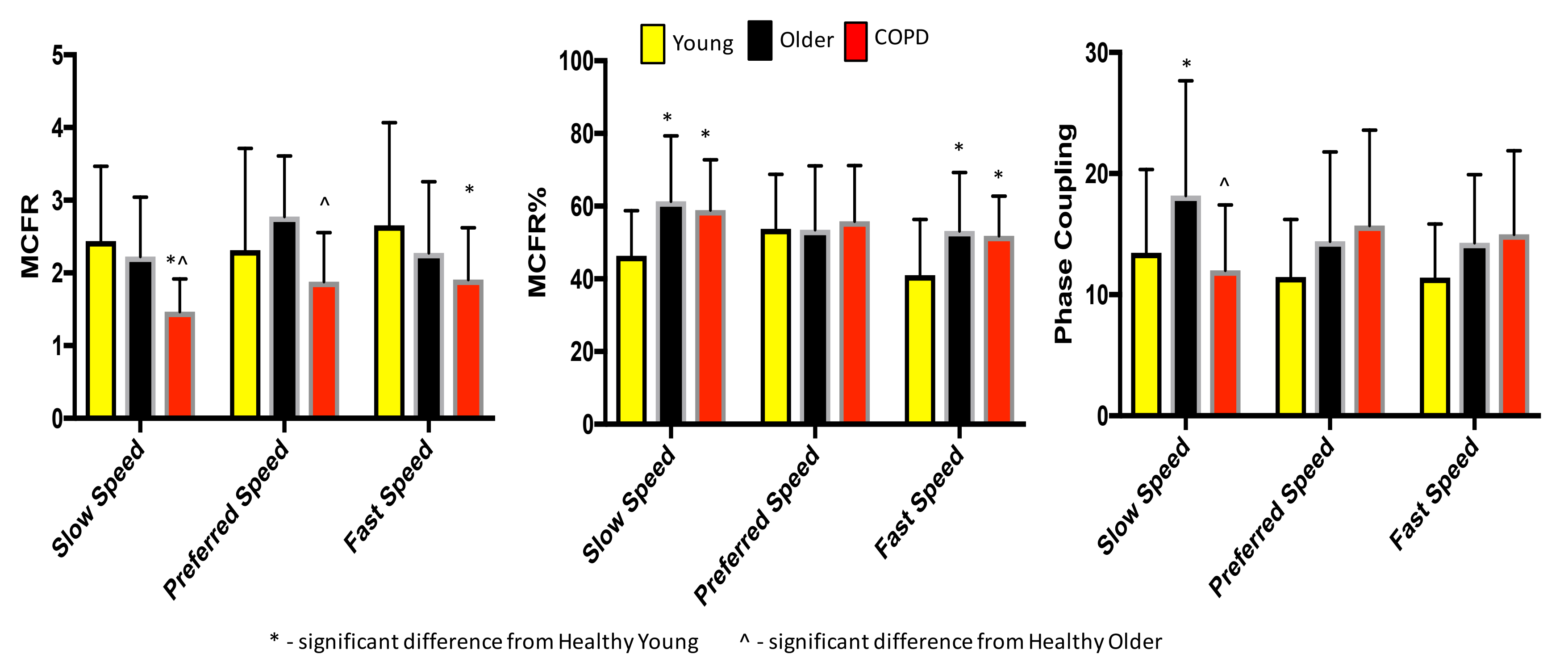


Figure 4. Comparison of MCFR, MCFR%, and Phase Coupling between groups at each walking speed. Healthy younger and older adults used a more complex MCFR compared to COPD patients ($p=0.02$) (Figure 4). COPD patients relied more on frequency ratios 1:1 and 1:5:1. Healthy older and COPD patients use their MCFR for a greater percentage of time than the healthy young participants ($p=0.04$). MCFR percentage decreased as speed increased ($p=0.02$) for all groups. No differences were found for PC.

DISCUSSION

- Although a similar theoretical approach to restricting breathing was used, healthy young adults were still able to maintain fairly normal coupling during restrictive breathing.
- Healthy young were not able to mimic the abnormal coupling found in patients with COPD.
- When compared to older adults and patients with COPD, healthy young did not demonstrate similar MCFR, MCFR%, or PC as compared to patients with COPD. Although most comparisons were not significantly different between healthy young and patients with COPD, qualitatively, they did not follow the same patterns.
- Future studies should explore other measures of coupling and/or different restrictive methods.

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