

**Maximum voluntary ventilation is more strongly associated with energy expenditure during simple activities of daily living than measures of airflow obstruction or respiratory muscle strength in patients with COPD**

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**ABSTRACT**

This is a retrospective analysis of data in which we explored the association between energy expenditure (EE) and lung function in patients with COPD. Thirty-six participants (20 males; FEV<sub>1</sub> 48±15% predicted) underwent measures of indirect calorimetry whilst performing five simple activities of daily living. Maximal voluntary ventilation was the only lung function parameter associated with EE. These data highlight the limited extent to which the FEV<sub>1</sub> is related to the functional performance of patients with COPD.

**Keywords:** Pulmonary disease, chronic obstructive; energy metabolism; activities of daily living, maximum voluntary ventilation, airflow obstruction.

## LETTER

In patients with chronic obstructive pulmonary disease (COPD), the relationship between energy expenditure (EE) and measures of lung function has attracted attention.<sup>1,2</sup>

Specifically, Pitta et al<sup>3</sup> demonstrated weak to moderate associations between measures of respiratory muscle strength, maximal voluntary ventilation (MVV), inspiratory capacity and forced expiratory volume in one second (FEV<sub>1</sub>) with EE measured over a 12 hour period in a group of people with COPD. However, as people with COPD are known to be very inactive,<sup>4</sup> it is possible that the measure of EE in this previous study<sup>3</sup> largely reflected resting EE, rather than EE related to specific activities of daily living (ADLs). Therefore, we sought to explore relationships between measures of lung function and respiratory muscle strength with EE elicited during ADLs, to ascertain which, if any, measurement influences the patient's performance of everyday tasks.

We conducted a novel retrospective analysis of previously published data.<sup>5</sup> The protocol required people with COPD to complete five tasks which replicated ADLs: walking; walking carrying a backpack; standing from a chair and sitting in another chair; walking up and down stairs and; moving an object in and out of a shelf. Tasks were one minute in duration, performed in random order at a self-selected pace. Measures of EE (kcal) were derived from the rate of oxygen uptake ( $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ) which was measured continuously via indirect calorimetry. Between tasks, participants rested until such time as heart rate and  $\text{VO}_2$  had returned to resting values. Measures were also completed of maximal inspiratory and expiratory pressures (MIP and MEP, respectively) and spirometry, including direct assessment of MVV.<sup>3</sup> All participants provided written informed consent for their data to be recorded. Data (mean $\pm$ SD) were available for 36 participants (20 males; FEV<sub>1</sub> 48 $\pm$ 15%

predicted; MVV  $43\pm 21$  L/min [ $43\pm 17\%$  predicted]) whose characteristics have been reported previously.<sup>5</sup>

Regarding the performance of each task, the distance covered during the walking and walking carrying a backpack activities were similar ( $48\pm 9$  and  $47\pm 9$ m, respectively [ $p=0.33$ ]). Participants completed  $13\pm 3$  transitions between the two chairs, walked up and down  $63\pm 18$  stairs and moved objects in and out of a shelf  $14\pm 3$  times. The average EE for the five tasks ranged between  $3.7\pm 1.4$ kcal (moving objects between shelves) to  $4.9\pm 1.7$ kcal (walking up and down stairs).

The MVV correlated with EE measured during every task as well as the total EE over the five tasks ( $0.39 < r < 0.54$ ,  $p < 0.05$ ; table 1). The only other significant (albeit weak) association demonstrated was between FEV<sub>1</sub> and EE measured walking up and down stairs ( $r=0.34$ ;  $p=0.04$ ). Forced vital capacity (FVC), MIP and MEP were not associated with any measure of EE. Our data demonstrates that MVV provided more information regarding EE elicited during simple ADLs than FEV<sub>1</sub>, FVC and measures of respiratory muscle strength. These results suggest that MVV may constitute a surrogate marker of EE elicited during ADLs. When measured in clinical practice, MVV may provide insight regarding those people with COPD who at greatest risk of a sedentary lifestyle.

#### **CONFLICT OF INTEREST STATEMENT**

The authors have no conflict of interest to declare.

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**Table 1.** Pearson's correlation coefficients (*r* values) between measures of respiratory function and energy expenditure (kcal) elicited during ADLs.

|                                    | FEV <sub>1</sub><br>(L) | FVC<br>(L) | MVV<br>(L/min)    | MIP<br>(cmH <sub>2</sub> O) | MEP<br>(cmH <sub>2</sub> O) |
|------------------------------------|-------------------------|------------|-------------------|-----------------------------|-----------------------------|
| Walking                            | 0.29                    | 0.05       | 0.47 <sup>#</sup> | 0.14                        | 0.12                        |
| Walking with backpack              | 0.21                    | -0.01      | 0.39*             | 0.03                        | 0.04                        |
| Moving between chairs              | 0.29                    | 0.15       | 0.53 <sup>#</sup> | 0.04                        | -0.01                       |
| Walking up and down stairs         | 0.34*                   | 0.04       | 0.54 <sup>#</sup> | 0.07                        | 0.06                        |
| Moving items in and out of a shelf | 0.25                    | 0.12       | 0.40*             | -0.01                       | -0.03                       |
| Total EE                           | 0.30                    | 0.08       | 0.50 <sup>#</sup> | 0.07                        | 0.04                        |

EE = energy expenditure; FEV<sub>1</sub> = forced expiratory volume in one second; FVC = forced vital capacity; MVV = maximal voluntary ventilation; MIP = maximal inspiratory pressure; MEP = maximal expiratory pressure

\**p*<0.05; <sup>#</sup> *p*<0.01