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Reduced level of physical activity in Japanese patients with chronic obstructive pulmonary disease

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ABSTRACT

Background: There is increasing interest in the quantification of physical activity (PA) with an accelerometer for the management of chronic obstructive pulmonary disease (COPD). However, a detailed understanding of the PA in Japanese patients with COPD is lacking. We evaluated the levels of PA in terms of intensity in Japanese patients with COPD and evaluated the factors, which could influence the PA.

Methods: Forty-three outpatients with COPD and 21 age-matched healthy subjects were monitored with a triaxial accelerometer, and their PA was compared. Furthermore, the effects of pulmonary function, ADO index (age, dyspnea, and airflow obstruction) and modified BODE index (body mass index, airflow obstruction, dyspnea, and exercise capacity) on the PA were evaluated.

Results: The PA in COPD was significantly reduced at all intensities. The reduced levels of PA in COPD were 23.1% at ≥2.0 metabolic equivalents (METs), 33.0% at ≥2.5 METs, 50.9% at ≥3.0 METs, and 66.9% at ≥3.5 METs, compared with that of healthy subjects, and the reduction was significant at GOLD stage III. The values of FVC, $FEV_{1.0}$, and DLCO/VA were correlated with that of the PA, but the lung volume parameters were not. The ADO and modified BODE indices were also well correlated with the PA.

Conclusions: The reduced levels of PA in Japanese patients with COPD were objectively demonstrated in terms of intensity that could provide us a new target for the management of COPD.

Abbreviations: PA, physical activity; ADO index, index including age, dyspnea, and airflow obstruction; BODE index, index including body-mass index, airflow obstruction, dyspnea, and exercise capacity; METs, metabolic equivalents; MMRC, modified Medical Research Council

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1. Introduction

Patients with chronic obstructive pulmonary disease (COPD) are often limited in their daily physical activity (PA), and the level of PA is related to the decline in lung function [1], as well as hospitalizations [2,3] and mortality [4]. Therefore, the PA in patients with COPD has received increasing clinical interest.

Recently, motion sensors, especially accelerometers, have been used to quantify the PA in patients with COPD [5–7], instead of questionnaires [8,9], which are less objective and reliable [10]. Among the reported accelerometers, the most reported and well-validated accelerometer for patients with COPD is the DynaPort Activity Monitor (DAM; McRoberts BV; The Hague, the Netherlands) [11–13]. However, it has several impediments to obtaining an accurate measurement of the PA, including the following: its battery only works for several hours, and the sensors are relatively large, so they should be worn on 2 parts of a patient's body (waist and left thigh). A compact and waist-worn type of triaxial accelerometer, the Actimarker (Panasonic; Osaka, Japan), can be operated continuously for more than 1 month and can evaluate the PA in patients with COPD more precisely, as well as in terms of the intensity of PA [14].

The limited parameters of the intensity of the PA in patients with COPD have been measured by arm-worn biaxial accelerometers [7,15]; however, such accelerometers are less accurate than waist-worn triaxial accelerometers [16], and PA with a limited intensity is less important than that of higher intensity for patients with COPD. Therefore, the intensity of PA in COPD is not clearly understood.

Furthermore, as socioeconomic and ethnic factors appear to influence patients with stable COPD [17], more specific details pertaining to the PA in Japanese patients with COPD should be objectively evaluated.

The aim of this study was to clarify the levels of PA in Japanese patients with COPD in terms of the intensity with a waist-worn triaxial accelerometer. Furthermore, we investigated whether pulmonary function, ADO index (age, dyspnea, and airflow obstruction), and modified BODE index (mBODE index; body mass index (BMI), airway obstruction, dyspnea, and exercise capacity) were associated with the PA in patients with COPD.

2. Material and methods

2.1. Subjects

Stable COPD patients (aged ≥60 years) without any other diseases that might interfere with walking were recruited from among the outpatients of Wakayama Medical University Hospital. COPD was diagnosed if the following condition existed: a post-bronchodilator forced expiratory volume in one second ($FEV_{1.0}$)/forced viral capacity (FVC) of <0.7. The patients did not have any other pulmonary diseases, such as asthma or bronchiectasis [18]. Age-matched healthy subjects were recruited from among members of senior citizens' clubs in Wakayama City, Wakayama Prefecture and Sakai City, Osaka Prefecture, Japan. Subjects with a pre-bronchodilator $FEV_{1.0}$/FVC <0.7, an $FEV_{1.0}$ %predicted <80%, or clinically evident diseases that might interfere with PA were excluded.

2.2. Protocol

Patients with COPD were assessed in terms of their stage, according to their post-bronchodilator $FEV_{1.0}$ upon entry. Then, they wore Actimarkers for 2 weeks and performed pre-bronchodilator pulmonary function tests and incremental shuttle walking tests (ISWT) on the last day of measurement. Healthy subjects wore Actimarkers for 2 weeks and performed pre-bronchodilator spirometries on the last day of measurement. Written informed consent was obtained from all participants, and the study was approved by the local ethics committee (Committee: IRB committee of Wakayama Medical University; authorization number: 968; date of approval: May 30, 2011).

2.3. Assessment of PA

The Actimarker is a small (74.5 × 13.4 × 34.0 mm) and lightweight (36.0 g) accelerometer that is worn only at the waist and can be continuously monitored for over 1 month. It collects the data of triaxial acceleration at 20 Hz, and the standard deviation of the data for 1 min is defined as the mean value of acceleration. The value of metabolic equivalents (METs) is calculated from the linear regression formula produced by the relationship between the mean value of acceleration and the METs measured using a respiratory gas metabolic system [19]. Actimarker was already validated for evaluating the PA in COPD in terms of intensities [14]. From among the 2-week monitoring data, 3 non-rainy weekdays from the beginning, except the first and last days, were extracted, and the mean values of the PA duration from the extracted 3 days were employed as representative values of the PA for individuals according to a previous investigation [14]. For each intensity of PA, the reduction in PA with COPD was calculated as follows: 100 × [(mean duration of PA in COPD)−(mean duration of PA in healthy subjects)]/(mean duration of PA in healthy subjects).

2.4. Assessment of physiological properties

The lung function was evaluated by CHESTAC-8800 DN type (Chest Ltd, Tokyo, Japan) for patients with COPD and HI-801 (Chest Ltd, Tokyo, Japan) for healthy subjects according to the recommendation of American Thoracic Society/European Respiratory Society [20]. ISWT was performed according to Singh's method (Japanese license number; 410) [21]. Dyspnea was evaluated with a modified Medical Research Council (MMRC) dyspnea scale [22], and modified BODE (mBODE) index, in which the original 6-min walking test [23] was substituted for the incremental shuttle walking test (point 0: >350 m; 1: 250–349 m; 2: 150–249 m; and 3: <149 m).

2.5. Statistical analysis

Statistical analysis was performed using GraphPad Prism 5 (GraphPad Software, San Diego, CA). The χ^2 test and unpaired t test were used for comparing the characteristic variables.