ORIGINAL ARTICLE

Physical Activity Patterns of Patients With Cardiopulmonary Illnesses

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ABSTRACT. Nguyen HQ, Steele BG, Dougherty CM, Burr RL. Physical activity patterns of patients with cardiopulmonary illnesses. Arch Phys Med Rehabil 2012;93:2360-6.

Objectives: The aims of this paper were (1) to describe objectively confirmed physical activity patterns across 3 chronic cardiopulmonary conditions, and (2) to examine the relationship between selected physical activity dimensions with disease severity, self-reported physical and emotional functioning, and exercise performance.

Design: Cross-sectional study.

Setting: Participants' home environment.

Participants: Patients with cardiopulmonary illnesses: chronic obstructive pulmonary disease (COPD) (n=63), heart failure (n=60), and patients with implantable cardioverter defibrillator (n=60).

Interventions: Not applicable.

Main Outcome Measures: Seven ambulatory physical activity dimensions (total steps, percent time active, percent time ambulating at low, medium, and high intensity, maximum cadence for 30 continuous minutes, and peak performance) were measured with an accelerometer.

Results: Subjects with COPD had the lowest amount of ambulatory physical activity compared with subjects with heart failure and cardiac dysrhythmias (all 7 activity dimensions, $P<.05$); total step counts were: 5319 versus 7464 versus 9570, respectively. Six-minute walk distance was correlated ($r=.44–.65$, $P<.01$) with all physical activity dimensions in the COPD sample, the strongest correlations being with total steps and peak performance. In subjects with cardiac impairment, maximal oxygen consumption had only small to moderate correlations with 5 of the physical activity dimensions ($r=.22–.40$, $P<.05$). In contrast, correlations between 6-minute walk test distance and physical activity were higher ($r=.48–.61$, $P<.01$) albeit in a smaller sample of only patients with heart failure. For all 3 samples, self-reported physical and mental health functioning, age, body mass index, airflow obstruction, and ejection fraction had either relatively small or nonsignificant correlations with physical activity.

Conclusions: All 7 dimensions of ambulatory physical activity discriminated between subjects with COPD, heart failure, and cardiac dysrhythmias. Depending on the research or clinical goal, use of 1 dimension, such as total steps, may be sufficient. Although physical activity had high correlations with performance on a 6-minute walk test relative to other variables, accelerometry-based physical activity monitoring provides unique, important information about real-world behavior in patients with cardiopulmonary illness not already captured with existing measures.

Key Words: Defibrillators, implantable; Heart failure; Pulmonary disease, chronic obstructive; Rehabilitation; Walking.

CARDIOPULMONARY DISEASES are the leading cause of morbidity and mortality worldwide.[1] Epidemiologic studies based on self-reported physical activity show that higher levels of activity are associated with lower risk of incident chronic obstructive pulmonary disease (COPD) in smokers and in patients with COPD, decreased risk of hospital admissions, exacerbations, and mortality.[2-4] A recent 4-year prospective study of 170 patients with COPD showed that objectively measured physical activity was the best predictor of all-cause mortality when compared with a broad range of other prognostic factors including airflow obstruction, exercise performance, cardiovascular status, nutritional and muscular status, systemic inflammation, health status, depressive symptoms, and dyspnea. Each increase of 1845 steps per day was associated with a 51% lower risk of death (hazard ratio, .49; 95% confidence interval, .35–.69).[5] The physiologic processes underlying the relationship between physical activity and survival are complex and only incompletely understood. However, it has been hypothesized that inactivity leads to cellular and molecular dysregulation, which directly contributes to the development of multiple chronic conditions.[6,7]

Similarly, associations have been found for self-reported physical activity with the primary and secondary prevention of cardiovascular diseases in a number of epidemiologic studies.[6-9] However, far fewer studies have been published on objectively measured physical activity in select cardiac populations, such as heart failure,[10-12] severe cardiac dysrhythmias, or coronary artery disease, to provide useful benchmarks of

List of Abbreviations

ATS	American Thoracic Society
COPD	chronic obstructive pulmonary disease
EF	ejection fraction
FEV_1	forced expiratory volume in 1 second
SAM	StepWatch 3 Activity Monitor
6MWT	6-minute walk test
$\dot{V}o_2max$	maximal oxygen consumption

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physical activity levels for comparisons across studies. Activity monitoring based on accelerometry can more precisely capture what patients actually do in their daily lives instead of what they report or what they are capable of with laboratory exercise testing.[13] While the pathophysiologic processes in the development of COPD, heart failure, and cardiac rhythm disorders differ, we posit that decreased physical activity is a common pathway to impaired functioning and disability in these and other chronic conditions[14] and that objective assessment of physical activity provides a unique but universal metric for comparison across diseases and studies. Therefore, the aims of this article are (1) to describe objectively confirmed physical activity patterns across 3 chronic cardiopulmonary conditions, and (2) to examine the relationship between selected physical activity dimensions with disease severity, self-reported physical and emotional functioning, and exercise performance.

METHODS

Participants

Between 2007 and 2010, a combined convenience sample of 183 outpatients at a Veterans Administration and university medical center were selected for study from the combined databases of 3 similar outpatient studies of activity patterns in cardiopulmonary illness.[15,16] All subjects had either a diagnosis of COPD, a history of life-threatening cardiac arrhythmias, or heart failure and had been clinically stable for at least 1 month and under optimal medical management. All subjects were able to read, speak, and write English and were not carrying out more than 2 days of supervised exercise per week. Subjects were excluded if they had less than 1 year to live, active malignancy, hypoxia with exertion (oxygen saturation $<86\%$ during exercise testing), significant psychiatric illness or recent drug abuse that would impair participation, and neuromuscular disease that limited daily activity. In addition, subjects were excluded if they evidenced disease exacerbation, uncontrolled cardiac dysrhythmias, unstable angina, recent myocardial infarction, or cardiothoracic surgery within the past 3 months.

COPD sample (n=63). The COPD subjects had to have at least mild COPD (Global Initiative for Obstructive Lung Disease stage I), defined as a postbronchodilator forced expiratory volume in 1 second (FEV_1)/forced vital capacity ratio $<.70$ with $FEV_1>80\%$ predicted with daily activities limited by dyspnea.

Heart failure sample (n=60). In addition to the general inclusion and exclusion criteria described earlier, heart failure subjects had to have an ejection fraction (EF) of $\leq.35$[17,18] and daily activities limited by dyspnea or fatigue.

Cardiac dysrhythmia sample (n=60). In addition to the general inclusion and exclusion criteria, the cardiac dysrhythmia sample had a history of life-threatening dysrhythmia that required the placement of an implantable cardioverter defibrillator for secondary prevention of sudden cardiac arrest. These subjects were also on beta blockers.

Measurements

Demographics. Data included self-reported age, sex, education, and marital status.

Health status. Health status included self-report of chronic conditions (Charlson comorbidity index), EF obtained from medical records, and spirometry, which was performed according to American Thoracic Society (ATS) standards using a Koko spirometer.[a] Postbronchodilator values were used.

Exercise performance. Performance was assessed using the 6-minute walk test (6MWT)[19] and a modified Balke treadmill symptom-limited test protocol.[20] Participants performed two 6MWTs according to ATS guidelines, and the longer of the 2 tests was used for analysis. Maximal oxygen consumption ($\dot{V}O_2max$) was measured during the cardiopulmonary exercise test session in an exercise laboratory and determined as the average value observed over the last 10 seconds of exercise (Viasys VMax series 229[b]).

Ambulatory physical activity. This was measured using a pager-sized, lightweight, StepWatch 3 Activity Monitor (SAM)[c] fastened above the right ankle. The SAM is a dual-axis accelerometer linked to a microprocessor sensor that directly and

Table 1: Subject Characteristics

Characteristics	COPD (n=63)	Heart Failure (n=60)	Cardiac Dysrhythmias (n=60)	Total (N=183)	ANOVA* (*P*)
Age	67.0±9.3	60.5±10.8	55.4±11.6	61.1±11.6	<.001†‡§
Sex (male)	58 (91)	57 (95)	44 (72)	159 (86)	<.001‡§
Ethnicity (white)	53 (83)	48 (80)	58 (95)	159 (86)	.040†‡§
Education (at least some college)	31 (48)	41 (73)	44 (72)	119 (64)	.006†‡
Body mass index	29.7±7.0	30.5±7.0	29.0±6.0	29.7±6.7	.460
Charlson comorbidity index	1.6±1.2	2.3±1.3	1.0±0.9	1.6±1.2	<.001†‡§
EF	55±8	27±7	49±11	41±15	<.001†§
Spirometry					
FEV_1 (% predicted)	36±15	72±20	85±15	64±27	<.001†‡§
FVC (% predicted)	57±16	73±17	85±14	72±20	<.001†‡§
FEV_1/FVC	0.46±0.16	0.73±0.11	0.73±0.08	0.64±0.17	<.001†‡
Health-related quality of life					
SF-36 physical component score	30.7±7.7	42.7±11.8	51.2±9.0	41.4±12.8	<.001†‡§
SF-36 mental component score	45.3±13.0	43.4±8.6	40.7±6.3	43.1±9.9	.035
Exercise performance					
6MWT (m)	340.2±113.1	385.2±104.4 (n=24)	NA	353.6±112.0	.094
$\dot{V}O_2max$ ($mL \cdot min^{-1} \cdot kg^{-1}$)	NA	20.3±5.3 (n=36)	24.4±6.1	22.8±6.1	.001

NOTE. Values shown are mean ± SD or count (%).
Abbreviations: ANOVA, analysis of variance; FVC, forced vital capacity; NA, not applicable; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey.
*Overall group comparison; pairwise comparisons with Bonferroni corrections: $P<.05$, †COPD versus heart failure, ‡COPD versus cardiac dysrhythmias, and §heart failure versus cardiac dysrhythmias.